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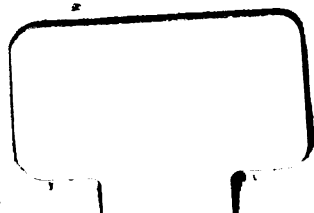
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Preface.

WE have long felt the need of a handy pocket edition of chemical tables *in English* for use in laboratories and chemical works. This compilation by Mr. Th. Breyer and Dr. H. Schweitzer has been very carefully prepared, and contains in a handy form the latest data as well as numerous tables not readily found elsewhere.

We believe that it will prove of great value not only to chemists but also to others engaged in chemical manufacturing.

DR. PETER T. AUSTEN,

*Late Professor of Chemistry, Rutgers College, and New Jersey State Scientific School; and
Chemist to the N. J. Agricultural College Experiment Station,
New Brunswick, N. J.*

DR. CHAS. F. CHANDLER,

Professor of Chemistry, Columbia College; College of Physicians and Surgeons and College of Pharmacy, New York, N. Y.

DR. HENRY MORTON,

President of Stevens Institute of Technology, Hoboken, N. J.

Introductory Remarks.

WE publish this little book, hoping that it may prove useful in every laboratory, in every factory, in every workshop,—wherever chemistry is either taught or applied.

Our extended experience in several of the largest chemical establishments of the world, and in the most renowned laboratories for research, coupled with the knowledge gained as consulting chemists to the leading manufacturers of the United States, has guided us—we hope—in selecting only such matter as may have value to our esteemed readers.

Whilst we are indebted to well-known standard books for a good many of the tables offered, we beg to call attention to the fact that a great number of others are the result of our own investigations.

We have adopted the new orthography of chemical terms as recommended by the Committee of the American Chemical Society.

TH. BREYER,

DR. H. SCHWEITZER,

Late Chemists with

*The Badische Anilin- und Soda-Fabrik, Ludwigshafen
on the Rhine;*

Strontianite Sugar Refining Co., Dessau in Anhalt;

F. O. Matthiessen & Wiechers, Jersey City, N. J.;

American Zylonite Co., Zylonite, Mass.;

And late Assistant Professors at

*The Agricultural Experiment Station, Munster, West-
phalia;*

*Agricultural High School Berlin, Laboratory for
Sugar Industry;*

Organic Laboratory, University of Heidelberg.

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CALENDAR AND NOTES.

1893.

JANUARY.

☉ Rises 7:25.

31 DAYS.

☉ Sets 4:44.

1. Sunday.

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JANUARY.

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JANUARY.

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JANUARY.

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JANUARY.

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FEBRUARY.

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FEBRUARY.

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FEBRUARY.

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FEBRUARY.

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FEBRUARY,

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MARCH.

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MARCH.

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MARCH.

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MARCH.

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JULY.

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JULY.

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JULY.

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AUGUST.

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AUGUST.

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AUGUST.

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AUGUST.

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SEPTEMBER.

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SEPTEMBER.

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SEPTEMBER.

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OCTOBER.

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DECEMBER.

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31. Sunday.

YEARLY CALENDAR.

1893.

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Jan.	1	2	3	4	5	6	7	May	1	2	3	4	5	6	7	Sept.	1	2	3	4	5	6	7
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	26	27	28						25	26	27	28	29	30			29	30	31				
Mar.	1	2	3	4	5	6	7	July	1	2	3	4	5	6	7	Nov.	1	2	3	4	5	6	7
	8	9	10	11	12	13	14		8	9	10	11	12	13		8	9	10	11	12	13	14	
	12	13	14	15	16	17	18		16	17	18	19	20	21	22		12	13	14	15	16	17	
	19	20	21	22	23	24	25		23	24	25	26	27	28	29		19	20	21	22	23	24	
	26	27	28	29	30	31			30	31							26	27	28	29	30		
Apr.	1	2	3	4	5	6	7	Aug.	1	2	3	4	5	6	7	Dec.	1	2	3	4	5	6	7
	8	9	10	11	12	13	14		8	9	10	11	12	13		8	9	10	11	12	13	14	
	16	17	18	19	20	21	22		13	14	15	16	17	18	19		10	11	12	13	14	15	
	23	24	25	26	27	28	29		20	21	22	23	24	25	26		17	18	19	20	21	22	
	30								27	28	29	30	31				24	25	26	27	28	29	
																	31						

1894.

Jan.	1	2	3	4	5	6	May	1	2	3	4	5	Sept.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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Information for the Laboratory.

A.—GENERAL PART.

I. CHEMICAL DIVISION.

2.

TABLE OF ATOMIC MASSES.

BY F. W. CLARKE.

Name.	Symbol	Atomic Mass.	Name.	Symbol	Atomic Mass.
Aluminum.....	Al	27.0	Neodymium.....	Nd	140.5
Antimony.....	Sb	120.0	Nickel.....	Ni	58.7
Arsenic.....	As	75.0	Nitrogen.....	N	14.08
Barium.....	Ba	137.0	Osmium.....	Os	190.8
Bismuth.....	Bi	208.9	Oxygen.....	O	16.0
Boron.....	B	11.0	Palladium.....	Pd	106.6
Bromin.....	Br	79.95	Phosphorus.....	P	31.0
Cadmium.....	Cd	112.0	Platinum.....	Pt	195.0
Caesium.....	Cs	132.9	Potassium.....	K	39.11
Calcium.....	Ca	40.0	Praseodymium..	Pr	143.5
Carbon.....	C	12.0	Rhodium.....	Rh	108.0
Cerium.....	Ce	140.2	Rubidium.....	Rb	85.5
Chlorin.....	Cl	35.45	Ruthenium.....	Ru	101.6
Chromium.....	Cr	52.1	Samarium.....	Sm	150.0
Cobalt.....	Co	59.0	Scandium.....	Sc	44.0
Columbium.....	Cb	94.0	Selenium.....	Se	79.0
Copper.....	Cu	63.6	Silicon.....	Si	28.4
Erbium.....	Er	166.3	Silver.....	Ag	107.92
Fluorin.....	F	19.0	Sodium.....	Na	23.05
Gadolinium.....	Gd	156.1	Strontium.....	Sr	87.6
Gallium.....	Ga	69.0	Sulfur.....	S	32.06
Germanium.....	Ge	72.8	Tantalum.....	Ta	182.6
Glucinum.....	Gl	9.0	Tellurium.....	Te	125.0
Gold.....	Au	197.3	Terbium.....	Tb	160.0
Hydrogen.....	H	1.007	Thallium.....	Tl	204.18
Indium.....	In	113.7	Thorium.....	Th	232.6
Iodin.....	I	126.85	Thulium.....	Tu	170.7
Iridium.....	Ir	193.1	Tin.....	Sn	119.0
Iron.....	Fe	56.0	Titanium.....	Ti	48.0
Lanthanum.....	La	138.2	Tungsten.....	W	184.0
Lead.....	Pb	206.95	Uranium.....	U	239.6
Lithium.....	Li	7.02	Vanadium.....	V	51.4
Magnesium.....	Mg	24.3	Ytterbium.....	Yb	173.0
Manganese.....	Mn	55.0	Yttrium.....	Yt	89.1
Mercury.....	Hg	200.0	Zinc.....	Zn	65.3
Molybdenum.....	Mo	96.0	Zirconium.....	Zr	90.6

3. PREPARATION OF REAGENTS ACCORDING TO E. BLOCHMANN.

The solutions are prepared in different strength as standard solutions. By preparing the reagents according to this system we have the following advantages:

The volumes of the various reagent's stand in a direct relation to each other, which prevents waste of reagents and permits an estimation of the quantities of substances reacted upon.

1. CONCENTRATED ACIDS.

	Specific gravity.	Per cent. by weight.
Concentrated hydrochloric acid.....	1.160	31.8
Concentrated nitric acid.....	1.805	48.1
Concentrated sulfuric acid.....	1.840	96.0

3—Continued. 2. STANDARD SOLUTIONS.

SOLUTIONS $\frac{1}{2}$ NORMAL.	Specific gravity.	Per cent. by weight.	1 liter contains grams.
ACIDS.			
Hydrochloric acid.....	1.034	7.1	73.0
Nitric acid.....	1.070	11.8	126.0
Sulfuric acid.....	1.063	9.2	98.0
Acetic acid.....	1.017	11.8	120.0
Oxalic acid.....	1.042	12.3	126.0
Tartaric acid.....	1.066	14.1	150.0
ALKALIES.			
Caustic potash.....	1.065	10.3	112.0
Caustic soda.....	1.064	7.4	80.0
Ammonia water.....	0.985	8.5	84.0
SALTS.			
Ammonium sulfid.....	1.0	6.8	68.0
Ammonium chlorid.....	1.032	10.4	107.0
Ammonium carbonate.....	1.025	9.4	96.0
Sodium carbonate.....	1.105	9.6	106.0
Sodium acetate.....	1.060	25.2	272.0
SOLUTIONS $\frac{1}{2}$ NORMAL.			
Sodium phosphate.....	1.048	11.4	119.2
Magnesium sulfate.....	1.059	11.6	123.0
Barium chlorid.....	1.088	11.2	122.0
Calcium chlorid.....	1.043	10.5	109.5
Iron chlorid.....	1.038	5.2	54.2
Lead acetate.....	1.118	16.9	139.5
Copper sulfate.....	1.075	11.6	124.8
Potassium iodid.....	1.120	14.8	166.0
Potassium chromate.....	1.075	9.0	97.3
Potassium ferrocyanid.....	1.060	10.0	105.5
SOLUTION $\frac{1}{2}$ NORMAL.			
Platinum chlorid.....	....	9.5	102.3
Silver nitrate.....	....	8.0	85.0
Mercury chlorid.....	....	6.4	67.8
Barium nitrate.....	....	6.2	65.2
3. SOLUTIONS OF REAGENTS OF OXIDATION AND REDUCTION.			
1 liter = $\frac{1}{2}$ O = 8 grams oxygen.			
Potassium bichromate.....	....	4.7	49.2
Sodium hypochlorite.....	....	8.7	87.2
Potassium nitrite.....	....	4.8	42.5
Stannous chlorid.....	....	10.5	112.5
4. SATURATED SOLUTION.			
Hydrogen sulfid (sulfuretted hydrogen).....	0.48	....	4.8
Barium hydroxid.....	8.2	....	82.0
Calcium hydroxid.....	0.7	....	7.0
Calcium sulfate.....	0.20	....	2.0
Bromin water.....	8.2	....	82.0
Iodin water.....	4.5	....	45.0

4. SPECIFIC GRAVITY AND DEGREES BEAUMÉ FOR LIQUIDS HEAVIER THAN WATER.

COMPILED BY C. F. CHANDLER.

(Temperature 10° R. — 12.5° C. — 54.5° F.)

Degrees Beaumé.	Specific gravity.	Degrees Beaumé.	Specific gravity.	Degrees Beaumé.	Specific gravity.	Degrees Beaumé.	Specific gravity.
0	1.00000	20	1.15497	39	1.35438	58	1.63701
1	1.00675	21	1.16399	40	1.36660	59	1.65519
2	1.01360	22	1.17316	41	1.37945	60	1.67378
3	1.02054	23	1.18246	42	1.39234	61	1.69279
4	1.02757	24	1.19192	43	1.40547	62	1.71223
5	1.03471	25	1.20153	44	1.41885	63	1.73213
6	1.04194	26	1.21129	45	1.43248	64	1.75250
7	1.04927	27	1.22122	46	1.44638	65	1.77335
8	1.05671	28	1.23131	47	1.46056	66	1.79470
9	1.06426	29	1.24156	48	1.47501	67	1.81657
10	1.07191	30	1.25199	49	1.48975	68	1.83899
11	1.07968	31	1.26260	50	1.50479	69	1.86196
12	1.08755	32	1.27338	51	1.52014	70	1.88551
13	1.09555	33	1.28436	52	1.53580	71	1.90967
14	1.10366	34	1.29552	53	1.55179	72	1.93446
15	1.11189	35	1.30688	54	1.56812	73	1.95989
16	1.12025	36	1.31844	55	1.58479	74	1.98601
17	1.12873	37	1.33021	56	1.60182	75	2.01283
18	1.13735	38	1.34218	57	1.61923	76	2.04038
19	1.14609						

5. SPECIFIC GRAVITY AND DEGREES BEAUMÉ FOR LIQUIDS LIGHTER THAN WATER.

COMPILED BY C. F. CHANDLER AND F. G. WIECHMANN.

Degrees Beaumé.	Specific gravity.	Degrees Beaumé.	Specific gravity.	Degrees Beaumé.	Specific gravity.	Degrees Beaumé.	Specific gravity.
10	1.0000	23	0.9183	36	0.8468	49	0.7892
11	0.9932	24	0.9125	37	0.8439	50	0.7849
12	0.9865	25	0.9068	38	0.8391	51	0.7807
13	0.9799	26	0.9012	39	0.8343	52	0.7766
14	0.9733	27	0.8957	40	0.8295	53	0.7725
15	0.9669	28	0.8902	41	0.8249	54	0.7684
16	0.9605	29	0.8848	42	0.8202	55	0.7644
17	0.9542	30	0.8795	43	0.8156	56	0.7604
18	0.9480	31	0.8742	44	0.8111	57	0.7565
19	0.9420	32	0.8690	45	0.8066	58	0.7526
20	0.9359	33	0.8639	46	0.8022	59	0.7487
21	0.9300	34	0.8588	47	0.7978	60	0.7449
22	0.9241	35	0.8538	48	0.7935	61	0.7411

6. SPECIFIC GRAVITY, DEGREES TWADDELL AND DEGREES BEAUMÉ.

Twaddell.	Beaumé.	Specific gravity.	Twaddell.	Beaumé.	Specific gravity.	Twaddell.	Beaumé.	Specific gravity.	Twaddell.	Beaumé.	Specific gravity.
0	0	1.000	44	26.0	1.220	88	44.1	1.440	132	57.4	1.660
1	0.7	1.005	45	26.4	1.225	89	44.4	1.445	133	57.7	1.665
2	1.4	1.010	46	26.9	1.230	90	44.8	1.450	134	57.9	1.670
3	2.1	1.015	47	27.4	1.235	91	45.1	1.455	135	58.2	1.675
4	2.7	1.020	48	27.9	1.240	92	45.4	1.460	136	58.4	1.680
5	3.4	1.025	49	28.4	1.245	93	45.8	1.465	137	58.7	1.685
6	4.1	1.030	50	28.8	1.250	94	46.1	1.470	138	58.9	1.690
7	4.7	1.035	51	29.3	1.255	95	46.4	1.475	139	59.2	1.695
8	5.4	1.040	52	29.7	1.260	96	46.8	1.480	140	59.5	1.700
9	6.0	1.045	53	30.2	1.265	97	47.1	1.485	141	59.7	1.705
10	6.7	1.050	54	30.6	1.270	98	47.4	1.490	142	60.0	1.710
11	7.4	1.055	55	31.1	1.275	99	47.8	1.495	143	60.2	1.715
12	8.0	1.060	56	31.5	1.280	100	48.1	1.500	144	60.4	1.720
13	8.7	1.065	57	32.0	1.285	101	48.4	1.505	145	60.6	1.725
14	9.4	1.070	58	32.4	1.290	102	48.7	1.510	146	60.9	1.730
15	10.0	1.075	59	32.8	1.295	103	49.0	1.515	147	61.1	1.735
16	10.6	1.080	60	33.3	1.300	104	49.4	1.520	148	61.4	1.740
17	11.2	1.085	61	33.7	1.305	105	49.7	1.525	149	61.6	1.745
18	11.9	1.090	62	34.2	1.310	106	50.0	1.530	150	61.8	1.750
19	12.4	1.095	63	34.6	1.315	107	50.3	1.535	151	62.1	1.755
20	13.0	1.100	64	35.0	1.320	108	50.6	1.540	152	62.3	1.760
21	13.6	1.105	65	35.4	1.325	109	50.9	1.545	153	62.5	1.765
22	14.2	1.110	66	35.8	1.330	110	51.2	1.550	154	62.8	1.770
23	14.9	1.115	67	36.2	1.335	111	51.5	1.555	155	63.0	1.775
24	15.4	1.120	68	36.6	1.340	112	51.8	1.560	156	63.2	1.780
25	16.0	1.125	69	37.0	1.345	113	52.1	1.565	157	63.5	1.785
26	16.5	1.130	70	37.4	1.350	114	52.4	1.570	158	63.7	1.790
27	17.1	1.135	71	37.8	1.355	115	52.7	1.575	159	64.0	1.795
28	17.7	1.140	72	38.2	1.360	116	53.0	1.580	160	64.2	1.800
29	18.3	1.145	73	38.6	1.365	117	53.3	1.585	161	64.4	1.805
30	18.8	1.150	74	39.0	1.370	118	53.6	1.590	162	64.6	1.810
31	19.3	1.155	75	39.4	1.375	119	53.9	1.595	163	64.8	1.815
32	19.8	1.160	76	39.8	1.380	120	54.1	1.600	164	65.0	1.820
33	20.3	1.165	77	40.1	1.385	121	54.4	1.605	165	65.2	1.825
34	20.9	1.170	78	40.5	1.390	122	54.7	1.610	166	65.5	1.830
35	21.4	1.175	79	40.8	1.395	123	55.0	1.615	167	65.7	1.835
36	22.0	1.180	80	41.2	1.400	124	55.2	1.620	168	65.9	1.840
37	22.5	1.185	81	41.6	1.405	125	55.5	1.625	169	66.1	1.845
38	23.0	1.190	82	42.0	1.410	126	55.8	1.630	170	66.3	1.850
39	23.5	1.195	83	42.3	1.415	127	56.0	1.635	171	66.5	1.855
40	24.0	1.200	84	42.7	1.420	128	56.3	1.640	172	66.7	1.860
41	24.5	1.205	85	43.1	1.425	129	56.6	1.645	173	67.0	1.865
42	25.0	1.210	86	43.4	1.430	130	56.9	1.650			
43	25.5	1.215	87	43.8	1.435	131	57.1	1.655			

7. SPECIFIC GRAVITY OF GASES AND VAPORS.

Gas or vapor.	Formula.	Mol. Wt.	Specific gravity (air=1).	Weight of 1 liter in grams at 0°C and 760 mm.
Acetone.....	C ³ H ⁶ O	58	2.0025	2.5896
Acetylene.....	C ² H ²	26	0.9200	1.1650
Air.....			1.0000	1.29387
Aldehyde.....	C ² H ⁴ O	44.0	1.5320	1.9811
Ammonia.....	NH ³	17.0	0.5960	0.7707
Amylic alcohol.....	C ⁶ H ¹² O	88.0	3.1470	4.0696
Arsenic.....	As ⁴	300.0	10.3900	13.4362
Arsenious anhydrid.....	As ² O ³	198.0	3.8500	7.9105
Arsine.....	AsH ³	78.0	2.6950	3.4851
Benzene.....	C ⁶ H ⁶	78.0	2.7700	3.5821
Bromin.....	Br ²	160.0	5.3933	6.8697
Butane.....	C ⁴ H ¹⁰	58.0	2.0041	2.5914
Carbon bisulfid.....	CS ²	76.0	2.6450	3.4204
Carbonic acid.....	CO ²	44.0	1.5290	1.9772
Carbon monoxid.....	CO	28.0	0.9674	1.2510
Carbon oxychlorid.....	COCl ²	99.0	3.4163	4.4174
Carbon-oxy-sulfid.....	COS	60.0	2.0748	2.6828
Chlorin.....	Cl ²	71.0	2.448	3.1801
Chlorin cyanid.....	CNCl	61.5	2.1244	2.7473
Chloroform.....	CHCl ³	119.5	4.2150	4.4507
Cyanogen.....	(CN) ²	52.0	1.8064	2.3360
Ethane.....	C ² H ⁶	30.0	1.0366	1.3404
Ether.....	C ⁴ H ¹⁰ O	74.0	2.5650	3.3170
Ether acetic.....	C ⁴ H ⁸ O ²	88.0	3.0670	3.9662
Ethyl alcohol.....	C ² H ⁶ O	46.0	1.6133	2.0662
Ethylene.....	C ² H ⁴	28.0	0.9674	1.2510
Hydrobromic acid.....	HBr	81.0	2.7310	3.5316
Hydrochloric acid.....	HCl	36.5	1.2474	1.6131
Hydrocyanic acid.....	CNH	27.0	0.9456	1.2228
Hydrofluoric acid.....	HF	20.0	0.6930	0.8960
Hydrogen.....	H ²	2.0	0.06926	0.08958
Hydrogen sulfid (sulfuretted hydrogen).....	H ² S	34.0	1.1921	1.5416
Hydroiodic acid.....	HI	128.0	4.4380	5.7456
Iodin.....	I ²	254.0	8.7160	11.2710
Mercury.....	Hg	200.0	6.9760	9.0210
Methane.....	CH ⁴	16.0	0.5560	0.7190
Methyl alcohol.....	CH ³ O	32.0	1.1200	1.4483
Nitric oxyd.....	NO	30.0	1.0390	1.3436
Nitrogen.....	N ²	28.0	0.97137	1.25617
Nitrous oxyd.....	N ² O	44.0	1.5269	1.9745
Oxygen.....	O ²	32.0	1.1056	1.4298
Phosphin (phosphoretted hydrogen).....	PH ³	34.0	1.1850	1.5350
Phosphorus.....	P ⁴	124.0	4.3550	5.6318
Phosphorus pentachlorid.....	PCl ⁵	208.5	8.6500	4.7201
Phosphorus trichlorid.....	PCl ³	137.5	4.7420	6.1299
Propane.....	C ³ H ⁸	44.0	1.5204	1.9660
Selenium.....	Se ²	158.0	5.7000	7.0229
Selenium hydrid.....	H ² Se	81.0	2.7846	3.6011
Silicium chlorid.....	SiCl ⁴	169.5	5.9390	7.6802

7—Continued.

Gas or vapor.	Formula.	Mol. Wt.	Specific gravity (air=1).	Weight of 1 liter in grams at 0°C and 760 mm.
Silicium fluorid.....	SiF ⁴	104.0	3.6000	4.6554
Steam.....	H ² O	18.0	0.6235	0.8063
Sulfur.....	S ²	64.0	2.2000	2.8430
Sulfuric acid.....	H ² SO ⁴	98.0	2.1500	2.7803
Sulfuric acid, anhydrous.....	SO ³	80.0	2.7630	3.5730
Sulfurous acid, anhydrous....	SO ²	64.0	2.234	2.8689
Tellurium	Te ²	256.0	8.9160	11.5310
Tellurium hydrid.....	H ² Te	130.0	4.5276	5.8550

8. SPECIFIC GRAVITY OF THE SOLID AND LIQUID ELEMENTS.

Aluminum (cast).....	2.56	Molybdenum	8.56
" (wrought).....	2.67	Neodymium	6.54
Antimony	6.7	Nickel	8.4-9.5
Arsenic.....	5.63	Osmium	22.48
Barium.....	4.0	Palladium	11.40
Bismuth.....	7.677	Phosphorus.....	1.84
Boron.....	2.68	" red	2.106
Bromin	3.15	Platinum	21.15
Cadmium.....	8.45	Potassium	0.865
Calcium.....	1.58	Praseodymium	6.54
Carbon (diamond).....	3.52	Rhodium.....	12.1
" (graphite).....	2.33	Rubidium	1.516
Cerium	6.6	Ruthenium	11.0-11.4
Chlorin (liquid).....	1.38	Selenium, amorphous.....	4.28
Chromium.....	7.01	" cryst.	4.80
Cobalt.....	8.957	Silicon.....	2.49
Columbium.....	6.67-7.37	Silver.....	10.53
Copper.....	8.958	Sodium.....	0.985
Gallium.....	5.9	Strontium	2.542
Germanium.....	5.47	Sulfur.....	2.07
Glucinum.....	2.1	" amorphous.	1.975
Gold.....	19.26	Tantalum.....	10.78
Indium	7.36	Tellurium.....	6.180
Iodin	4.948	Thallium.....	11.81
Iridium.....	22.42	Thorium.....	11.00
Iron	7.79	Tin.....	7.29
Steel.....	7.62	Tungsten.....	17.1-18.3
Lead.....	11.33	Uranium	18.4
Lithium	0.594	Vanadium	5.5
Magnesium.....	1.70	Zinc.....	7.13
Manganese.....	8.03	Zirconium.....	4.15
Mercury	13.60		

9. SPECIFIC GRAVITY OF VARIOUS SOLID SUBSTANCES.

Alabaster...	2.59	Glass, Bohemian cryst, 2 9	-3.0
Anthracite.....	1.4 -1.7	" flint, English..	3.4 -3.44
Asphalt.....	1.1 -1.2	Granite.....	2.5 -2.9
Alder.....	0.5 -0.6	Gum arabic.....	1.31 -1.45
Basalt.....	2.8 -3.2	Gunpowder...	0.836-1.745
Beech.....	0.7 -0.8	Gutta-percha.....	0.96 -0.98
Birch.....	0.7 -0.8	Ivory.....	1.8 -1.9
Bone.....	1.8 -2.0	Lignite.....	1.2 -1.4
Brass.....	8.4 -8.7	Limestone.....	2.6 -2.8
Brick.....	1.4 -2.3	Maple.....	0.687
Cannel-coal.....	1.16-1.27	Manganese peroxid...	4.7 -5.0
Caoutchouc.....	0.93	Marble.....	2.5 -2.8
Cement.....	2.7 -3.05	Oak.....	0.85 -0.95
Charcoal.....	0.3 -0.5	Pine.....	0.5
Clay.....	1.8 -2.6	Porcelain.....	2.1 -2.5
Fat (animal).....	0.92	Pumice-stone.....	0.91 -1.6
Felspar.....	2.5 -2.6	Resin.....	1.07
Fibre (vegetable).....	1.51	Sand.....	1.4 -1.6
Flour (wheat).....	1.56	Sandstone.....	1.9 -2.5
Glass (green).....	2.642	Sugar.....	-1.61
" (mirror).....	2.450	Wax (bee).....	0.96

10. DENSITY AND VOLUME OF WATER AT DIFFERENT TEMPERATURES (ROSETTI).

Temp.	Density.	Volume.	Temp.	Density.	Volume.	Temp.	Density.	Volume.
-10	0.998145	1.001858	6	0.999970	1.000080	22	0.997826	1.002177
-9	427	375	7	983	67	23	601	405
-8	685	317	8	886	114	24	367	641
-7	911	089	9	824	176	25	120	8-8
-6	9118	0883	10	747	253	26	6866	3144
-5	298	703	11	655	345	27	603	408
-4	455	545	12	549	451	28	331	632
-3	590	410	13	430	570	29	051	965
-2	708	297	14	299	701	30	5765	4253
-1	797	203	15	160	841	40	235	770
0	871	129	16	002	999	50	8820	1195
1	928	73	17	8841	1160	60	338	691
2	969	31	18	654	348	70	7794	2256
3	991	9	19	460	542	80	194	887
4	1.000000	1.000000	20	259	744	90	6556	3567
5	0.999990	10	21	047	957	100	0.95865	1.04312

The figures given for specific gravity in the following tables are generally determined in comparison with water of 15° Celsius. To find the true specific gravity at this temperature in comparison with water of 4° C., they are to be multiplied by 0.99916 (see table 10).

A.—ALKALIES.

11. SPECIFIC GRAVITY OF AMMONIA WATER AT 14° (CARIOUS).

Specific gravity.	% Ammonia	Specific gravity.	% Ammonia	Specific gravity.	% Ammonia	Specific gravity.	% Ammonia
0.8844	36.0	0.9052	27.0	0.9814	18.0	0.9631	9.0
0.8848	35.8	0.9057	26.8	0.9821	17.8	0.9639	8.8
0.8852	35.6	0.9063	26.6	0.9827	17.6	0.9647	8.6
0.8856	35.4	0.9068	26.4	0.9833	17.4	0.9654	8.4
0.8860	35.2	0.9073	26.2	0.9840	17.2	0.9662	8.2
0.8864	35.0	0.9078	26.0	0.9847	17.0	0.9670	8.0
0.8868	34.8	0.9083	25.8	0.9853	16.8	0.9677	7.8
0.8872	34.6	0.9089	25.6	0.9860	16.6	0.9685	7.6
0.8877	34.4	0.9094	25.4	0.9866	16.4	0.9693	7.4
0.8881	34.2	0.9100	25.2	0.9873	16.2	0.9701	7.2
0.8885	34.0	0.9106	25.0	0.9880	16.0	0.9709	7.0
0.8889	33.8	0.9111	24.8	0.9886	15.8	0.9717	6.8
0.8894	33.6	0.9116	24.6	0.9893	15.6	0.9725	6.6
0.8898	33.4	0.9122	24.4	0.9900	15.4	0.9733	6.4
0.8903	33.2	0.9127	24.2	0.9907	15.2	0.9741	6.2
0.8907	33.0	0.9133	24.0	0.9914	15.0	0.9749	6.0
0.8911	32.8	0.9139	23.8	0.9920	14.8	0.9757	5.8
0.8916	32.6	0.9145	23.6	0.9927	14.6	0.9765	5.6
0.8920	32.4	0.9150	23.4	0.9934	14.4	0.9773	5.4
0.8925	32.2	0.9156	23.2	0.9941	14.2	0.9781	5.2
0.8929	32.0	0.9162	23.0	0.9949	14.0	0.9790	5.0
0.8934	31.8	0.9168	22.8	0.9956	13.8	0.9799	4.8
0.8938	31.6	0.9174	22.6	0.9963	13.6	0.9807	4.6
0.8943	31.4	0.9180	22.4	0.9970	13.4	0.9815	4.4
0.8948	31.2	0.9185	22.2	0.9977	13.2	0.9823	4.2
0.8953	31.0	0.9191	22.0	0.9984	13.0	0.9831	4.0
0.8957	30.8	0.9197	21.8	0.9991	12.8	0.9839	3.8
0.8962	30.6	0.9203	21.6	0.9998	12.6	0.9847	3.6
0.8967	30.4	0.9209	21.4	0.9505	12.4	0.9855	3.4
0.8971	30.2	0.9215	21.2	0.9512	12.2	0.9863	3.2
0.8976	30.0	0.9221	21.0	0.9520	12.0	0.9873	3.0
0.8981	29.8	0.9227	20.8	0.9527	11.8	0.9882	2.8
0.8986	29.6	0.9233	20.6	0.9534	11.6	0.9890	2.6
0.8991	29.4	0.9239	20.4	0.9542	11.4	0.9899	2.4
0.8996	29.2	0.9245	20.2	0.9549	11.2	0.9907	2.2
0.9001	29.0	0.9251	20.0	0.9556	11.0	0.9915	2.0
0.9006	28.8	0.9257	19.8	0.9563	10.8	0.9924	1.8
0.9011	28.6	0.9264	19.6	0.9571	10.6	0.9933	1.6
0.9016	28.4	0.9271	19.4	0.9578	10.4	0.9941	1.4
0.9021	28.2	0.9277	19.2	0.9586	10.2	0.9950	1.2
0.9026	28.0	0.9283	19.0	0.9593	10.0	0.9959	1.0
0.9031	27.8	0.9289	18.8	0.9601	9.8	0.9967	0.8
0.9036	27.6	0.9296	18.6	0.9608	9.6	0.9975	0.6
0.9041	27.4	0.9302	18.4	0.9616	9.4	0.9983	0.4
0.9047	27.2	0.9308	18.2	0.9623	9.2	0.9991	0.2

12. SPECIFIC GRAVITY OF CAUSTIC POTASH AT 15° (LUNGE).

Specific gravity.	Beaumé	Twaddell.	100 parts (by weight) contain		1 cubic meter contains kilos.	
			K ² O	KOH	K ² O	KOH
1.007	1	1.4	0.7	0.9	7	9
1.014	2	2.8	1.4	1.7	14	17
1.022	3	4.4	2.2	2.6	22	26
1.029	4	5.8	2.9	3.5	30	36
1.037	5	7.4	3.8	4.5	39	46
1.045	6	9.0	4.7	5.6	49	58
1.052	7	10.4	5.4	6.4	57	67
1.060	8	12.0	6.2	7.4	66	78
1.067	9	13.4	6.9	8.2	74	88
1.075	10	15.0	7.7	9.2	83	99
1.083	11	16.6	8.5	10.1	92	109
1.091	12	18.2	9.2	10.9	100	119
1.100	13	20.0	10.1	12.0	111	132
1.108	14	21.6	10.8	12.9	119	143
1.116	15	23.2	11.6	13.8	129	153
1.125	16	25.0	12.4	14.8	140	167
1.134	17	26.8	13.2	15.7	150	178
1.142	18	28.4	13.9	16.5	159	188
1.152	19	30.4	14.8	17.6	170	203
1.162	20	32.4	15.6	18.6	181	216
1.171	21	34.2	16.4	19.5	192	228
1.180	22	36.0	17.2	20.5	203	242
1.190	23	38.0	18.0	21.4	214	255
1.200	24	40.0	18.8	22.4	226	269
1.210	25	42.0	19.6	23.3	237	282
1.220	26	44.0	20.3	24.2	248	295
1.231	27	46.2	21.1	25.1	260	309
1.241	28	48.2	21.9	26.1	272	324
1.252	29	50.4	22.7	27.0	284	338
1.263	30	52.6	23.5	28.0	297	353
1.274	31	54.8	24.2	28.9	308	368
1.285	32	57.0	25.0	29.8	321	385
1.297	33	59.4	25.8	30.7	335	398
1.308	34	61.6	26.7	31.8	349	416
1.320	35	64.0	27.5	32.7	363	432
1.332	36	66.4	28.3	33.7	377	449
1.345	37	69.0	29.3	34.9	394	469
1.357	38	71.4	30.2	35.9	410	487
1.370	39	74.0	31.0	36.9	425	506
1.383	40	76.6	31.8	37.8	440	522
1.397	41	79.4	32.7	38.9	457	543
1.410	42	82.0	33.5	39.9	472	563
1.424	43	84.8	34.4	40.9	490	582
1.438	44	87.6	35.4	42.1	509	605
1.453	45	90.6	36.5	43.4	530	631
1.468	46	93.6	37.5	44.6	549	655
1.483	47	96.6	38.5	45.8	571	679
1.498	48	99.6	39.6	47.1	598	706
1.514	49	102.8	40.6	48.3	615	731
1.530	50	106.0	41.5	49.4	635	756
1.546	51	109.2	42.5	50.6	655	779

12—Continued.

Specific gravity.	Beaumé	Twaddell.	100 parts (by weight) contain		1 cubic meter contains kilos.	
			K ² O	KOH	K ² O	KOH
1.568	52	112.6	43.6	51.9	681	811
1.580	53	116.0	44.7	53.2	706	840
1.597	54	119.4	45.8	54.5	731	870
1.615	55	123.0	47.0	55.9	754	902
1.634	56	126.8	48.3	57.5	780	940

13. SPECIFIC GRAVITY OF CAUSTIC SODA AT 15° (LUNGE).

Specific gravity.	Beaumé	Twaddell.	Per cent. Na ² O	Per cent. NaOH	1 cubic meter contains kilos.	
					Na ² O	NaOH
1.007	1	1.4	0.47	0.61	4	6
1.014	2	2.8	0.93	1.20	9	12
1.022	3	4.4	1.55	2.00	16	21
1.030	4	5.8	2.10	2.71	22	28
1.036	5	7.2	2.60	3.35	27	35
1.045	6	9.0	3.10	4.00	32	42
1.052	7	10.4	3.60	4.64	38	49
1.060	8	12.0	4.10	5.29	43	56
1.067	9	13.4	4.55	5.87	49	63
1.075	10	15.0	5.08	6.55	55	70
1.083	11	16.6	5.67	7.31	61	79
1.091	12	18.2	6.30	8.00	68	87
1.100	13	20.0	6.73	8.68	74	95
1.108	14	21.6	7.30	9.43	81	104
1.116	15	23.2	7.80	10.06	87	112
1.125	16	25.0	8.50	10.97	96	123
1.134	17	26.8	9.18	11.84	104	134
1.142	18	28.4	9.80	12.64	112	144
1.152	19	30.4	10.50	13.53	121	156
1.162	20	32.4	11.14	14.37	129	167
1.171	21	34.2	11.73	15.13	137	177
1.180	22	36.0	12.33	15.91	146	188
1.190	23	38.0	13.00	16.77	155	200
1.200	24	40.0	13.70	17.67	164	212
1.210	25	42.0	14.40	18.58	174	225
1.220	26	44.0	15.18	19.58	185	239
1.231	27	46.2	15.96	20.59	196	253
1.241	28	48.2	16.76	21.42	208	266
1.252	29	50.4	17.55	22.64	220	283
1.263	30	52.6	18.35	23.67	232	299
1.274	31	54.8	19.23	24.81	245	316
1.285	32	57.0	20.00	25.80	257	332
1.297	33	59.4	20.80	26.83	270	348
1.308	34	61.6	21.55	27.80	282	364
1.320	35	64.0	22.35	28.83	295	381
1.332	36	66.4	23.20	29.93	309	399
1.345	37	69.0	24.20	31.22	323	420
1.357	38	71.4	25.17	32.47	342	441

13—Continued.

Specific gravity.	Beaumé	Twaddell.	Per cent. Na ² O	Per cent.	1 cubic meter contains kilos.	
					Na ² O	NaOH
1.370	39	71.0	26.12	33.69	359	463
1.383	40	76.6	27.10	34.96	375	483
1.397	41	79.4	28.10	36.25	392	506
1.410	42	82.0	29.05	37.47	410	528
1.424	43	84.8	30.08	38.80	428	553
1.438	44	87.6	31.00	39.99	446	575
1.453	45	90.6	32.10	41.41	466	602
1.468	46	93.6	33.20	42.83	487	629
1.483	47	96.6	34.40	44.38	510	658
1.498	48	99.6	35.70	46.15	535	691
1.514	49	102.8	36.90	47.60	559	721
1.530	50	106.0	38.00	49.02	581	750

14. SPECIFIC GRAVITY OF MILK OF LIME AND PERCENTAGE OF LIME AT 15° (LUNGE AND BLATTNER).

Degrees Beaumé.	1 liter Milk of Lime weighs in grams.	CaO in 1 liter grams.	CaO per cent. by weight.
1	1007	7.5	0.745
2	1014	16.5	1.64
3	1022	26.0	2.54
4	1029	36.0	3.54
5	1037	46.0	4.43
6	1045	56.0	5.36
7	1052	65.0	6.18
8	1060	75.0	7.08
9	1067	84.0	7.87
10	1073	94.0	8.74
11	1083	104.0	9.60
12	1091	115.0	10.54
13	1100	126.0	11.45
14	1108	137.0	12.35
15	1116	148.0	13.26
16	1125	159.0	14.13
17	1134	170.0	15.00
18	1142	181.0	15.85
19	1152	193.0	16.75
20	1162	206.0	17.72
21	1171	218.0	18.61
22	1180	229.0	19.40
23	1190	242.0	20.34
24	1200	255.0	21.25
25	1210	268.0	22.15
26	1220	281.0	23.03
27	1231	295.0	23.96
28	1241	309.0	24.90
29	1252	324.0	25.87
30	1263	339.0	26.84

B.-ACIDS.**15. MURIATIC ACID. SPECIFIC GRAVITY, PERCENTAGE OF HYDRO-CHLORIC ACID AND CHLORIN AT 15° C. (URE).**

Specific gravity.	Hydro-chloric Acid.	Chlorin.	Specific gravity.	Hydro-chloric Acid.	Chlorin.
1.2000	40.777	39.675	1.1102	22.426	21.822
1.1982	40.369	39.278	1.1082	22.019	21.425
1.1964	39.961	38.882	1.1061	21.611	21.028
1.1946	39.554	38.485	1.1041	21.203	20.632
1.1928	39.146	38.089	1.1020	20.796	20.235
1.1910	38.738	37.692	1.1000	20.388	19.837
1.1893	38.330	37.296	1.0980	19.980	19.440
1.1875	37.923	36.900	1.0960	19.572	19.044
1.1857	37.516	36.503	1.0939	19.165	18.647
1.1846	37.108	36.107	1.0919	18.757	18.250
1.1822	37.700	35.707	1.0899	18.349	17.854
1.1802	36.292	35.310	1.0879	17.941	17.457
1.1782	35.884	34.913	1.0859	17.534	17.060
1.1762	35.476	34.517	1.0838	17.126	16.664
1.1741	35.068	34.121	1.0818	16.718	16.267
1.1721	34.660	33.724	1.0798	16.310	15.870
1.1701	34.252	33.328	1.0778	15.902	15.474
1.1681	33.845	32.931	1.0758	15.494	15.077
1.1661	33.437	32.535	1.0738	15.087	14.680
1.1641	33.029	32.138	1.0718	14.679	14.284
1.1620	32.621	31.746	1.0697	14.271	13.887
1.1599	32.213	31.343	1.0677	13.863	13.490
1.1578	31.805	30.946	1.0657	13.456	13.094
1.1557	31.398	30.550	1.0637	13.049	12.697
1.1537	30.990	30.153	1.0617	12.641	12.300
1.1515	30.582	29.757	1.0597	12.233	11.903
1.1494	30.174	29.361	1.0577	11.825	11.506
1.1473	29.767	28.964	1.0557	11.418	11.109
1.1452	29.359	28.567	1.0537	11.010	10.712
1.1431	28.951	28.171	1.0517	10.602	10.316
1.1410	28.544	27.772	1.0497	10.194	9.919
1.1389	28.136	27.376	1.0477	9.786	9.522
1.1369	27.728	26.979	1.0457	9.379	9.126
1.1349	27.321	26.583	1.0437	8.971	8.729
1.1328	26.913	26.186	1.0417	8.563	8.332
1.1308	26.506	25.789	1.0397	8.155	7.935
1.1287	26.098	25.392	1.0377	7.747	7.528
1.1267	25.690	24.996	1.0357	7.340	7.141
1.1247	25.282	24.599	1.0337	6.932	6.745
1.1226	24.874	24.202	1.0318	6.524	6.348
1.1206	24.466	23.805	1.0298	6.116	5.951
1.1186	24.058	23.408	1.0279	5.709	5.554
1.1164	23.650	23.012	1.0259	5.301	5.158
1.1143	23.242	22.615	1.0239	4.893	4.762
1.1123	22.834	22.218	1.0220	4.486	4.365

15—Continued.

Specific gravity.	Hydrochloric Acid.	Chlorin.	Specific gravity.	Hydrochloric Acid.	Chlorin.
1.0200	4.078	3.963	1.0100	2.089	1.984
1.0180	3.870	3.571	1.0080	1.631	1.588
1.0160	3.262	3.174	1.0060	1.124	1.191
1.0140	2.854	2.778	1.0040	0.816	0.795
1.0120	2.447	2.381	1.0020	0.408	0.397

15b. SPECIFIC GRAVITY OF MURIATIC ACID (KOLB).

Degrees Beaumé.	Specific gravity.	100 parts contain at 0° C. HCl	100 parts contain at 15° C.			
			HCl	Acid of 20° B.	Acid of 21° B.	Acid of 22° B.
0.0	1.000	0.0	0.1	0.3	0.3	0.3
1.0	1.007	1.4	1.5	4.7	4.4	4.2
2.0	1.014	2.7	2.9	9.0	8.6	8.1
3.0	1.022	4.2	4.5	14.1	13.3	12.6
4.0	1.029	5.5	5.8	18.1	17.1	16.2
5.0	1.036	6.9	7.3	22.8	21.5	20.4
6.0	1.044	8.4	8.9	27.3	26.2	24.4
7.0	1.052	9.9	10.4	32.6	30.7	29.1
8.0	1.060	11.4	12.0	37.6	35.4	33.6
9.0	1.067	12.7	13.4	41.9	39.5	37.5
10.0	1.075	14.2	15.0	46.9	44.2	42.0
11.0	1.083	15.7	16.5	51.6	48.7	46.2
12.0	1.091	17.2	18.1	56.7	53.4	50.7
13.0	1.100	18.9	19.9	62.3	58.7	55.7
14.0	1.108	20.4	21.5	67.3	63.4	60.2
15.0	1.116	21.9	23.1	72.3	68.1	64.7
16.0	1.125	23.6	24.8	77.6	73.2	69.4
17.0	1.134	25.2	26.6	83.3	78.5	74.5
18.0	1.143	27.0	28.4	88.9	83.0	79.5
19.0	1.152	28.7	30.2	94.5	89.0	84.6
19.5	1.157	29.7	31.2	97.7	92.0	87.4
20.0	1.161	30.4	32.0	100.0	94.4	89.6
20.5	1.166	31.4	33.0	103.8	97.3	92.4
21.0	1.171	32.3	33.9	106.1	100.0	94.9
21.5	1.175	33.0	34.7	108.6	102.4	97.2
22.0	1.180	34.1	35.7	111.7	105.3	100.0
22.5	1.185	35.1	36.8	115.2	108.6	103.0
23.0	1.190	36.1	37.9	118.6	111.8	106.1
23.5	1.195	37.1	39.0	122.0	115.0	109.2
24.0	1.199	38.0	39.8	124.6	117.4	111.4
24.5	1.205	39.1	41.2	130.0	121.5	115.4
25.0	1.210	40.2	42.4	132.7	125.0	119.0
25.5	1.212	41.7	42.9	131.3	126.6	120.1

16. SPECIFIC GRAVITY OF NITRIC ACID, PERCENTAGE OF HNO_3 (KOLB).

Degrees Beaumé.	Specific gravity.	100 parts contain at 0° C.		100 parts contain at 15°.		Degrees Beaumé.	Specific gravity.	100 parts contain at 0° C.		100 parts contain at 15°.	
		NO^3H	N^2O^5	NO^3H	N^2O^5			NO^3H	N^2O^5	NO^3H	N^2O^5
0.0	1.000	0.0	0.0	0.2	0.1	28.0	1.242	36.2	31.0	38.6	33.1
1.0	1.007	1.1	0.9	1.5	1.3	29.0	1.252	37.7	32.3	40.2	34.5
2.0	1.014	1.2	1.9	2.6	2.2	30.0	1.261	39.1	33.5	41.5	35.6
3.0	1.022	3.4	2.9	4.0	3.4	31.0	1.275	41.1	35.2	43.5	37.3
4.0	1.029	4.5	3.9	5.1	4.4	32.0	1.286	42.6	36.5	45.0	38.6
5.0	1.036	5.5	4.7	6.3	5.4	33.0	1.298	44.4	38.0	47.1	40.4
6.0	1.044	6.7	5.7	7.6	6.5	34.0	1.309	46.1	39.5	48.6	41.7
7.0	1.052	8.0	6.9	9.0	7.7	35.0	1.321	48.0	41.1	50.7	43.5
8.0	1.060	9.2	7.9	10.2	8.7	36.0	1.334	50.0	42.9	52.9	45.3
9.0	1.067	10.3	8.7	11.4	9.8	37.0	1.346	51.9	44.5	55.0	47.1
10.0	1.075	11.4	9.8	12.7	10.9	38.0	1.359	54.0	46.3	57.3	49.1
11.0	1.083	12.6	10.8	14.0	12.0	39.0	1.372	56.2	48.2	59.6	51.1
12.0	1.091	13.8	11.8	15.3	13.1	40.0	1.384	58.4	50.0	61.7	52.9
13.0	1.100	15.2	13.0	16.8	14.4	41.0	1.398	60.8	52.1	64.5	55.3
14.0	1.108	16.4	14.0	18.0	15.4	42.0	1.412	63.2	54.2	67.5	57.9
15.0	1.116	17.6	15.1	19.4	16.6	43.0	1.426	65.2	56.7	70.6	60.5
16.0	1.125	18.9	16.2	20.8	17.8	44.0	1.440	69.0	59.1	74.4	63.8
17.0	1.134	20.2	17.3	22.2	19.0	45.0	1.454	72.2	61.9	78.4	67.2
18.0	1.143	21.6	18.5	23.6	20.2	46.0	1.470	76.1	65.2	83.0	71.1
19.0	1.153	22.9	19.6	24.9	21.3	47.0	1.485	80.2	68.7	87.1	74.7
20.0	1.161	24.2	20.7	26.3	22.5	48.0	1.501	84.5	72.4	92.6	79.4
21.0	1.171	25.7	22.0	27.8	23.8	49.0	1.516	88.4	75.8	96.0	82.3
22.0	1.180	27.0	23.1	29.2	25.0	49.5	1.524	90.5	77.6	98.0	84.0
23.0	1.190	28.5	24.4	30.7	26.3	49.9	1.530	92.2	79.0	100.0	85.71
24.0	1.199	29.8	25.5	32.1	27.5	50.0	1.532	92.7	79.5		
25.0	1.210	31.4	26.9	33.8	28.9	50.5	1.541	95.0	81.4		
26.0	1.221	33.1	28.4	35.5	30.4	51.0	1.549	97.3	83.4		
27.0	1.231	34.6	29.7	37.0	31.7	51.5	1.559	100.0	85.71		

17.

SULFURIC ACID.

BY ARTHUR H. ELLIOTT, F.C.S.

The accompanying table is the result of a careful selection of figures from standard authorities, and calculations from those figures have been worked out into forms that are constantly needed in a chemical manufactory. The columns with headings marked "Degrees Beaumé," "Specific gravity," and "Per cent. of H_2SO_4 ," are after the figures of the table of the Manufacturing Chemists' Association. A comparison of these figures with those of Bineau and Kolb shows them to be the latest and most reliable result. The sixty-sixth degree of Beaumé* is placed at 1.835 specific gravity, not be-

*The total number of degrees of this areometer would be 145. (N.=145.04.)

cause this is the highest attainable strength, but because this is the specific gravity of the acid sold and branded "66° Oil of Vitriol" in commerce. Acid of a higher specific gravity is difficult to prepare, and is unnecessary for the ordinary uses to which Oil of Vitriol is put. In other words, "Oil of Vitriol" contains ninety-three and a half per cent. of monohydrated acid (H^2SO^4), and this is now a settled question among chemical manufacturers.

Starting with the above data, I have calculated the weight of a cubic foot of acid at the various densities, and worked out the figures in the other columns. I have added the nearest degree of Twaddell's hydrometer corresponding to the various specific gravities. This latter hydrometer is a much more reliable instrument to place in the hands of a workman than that of Beaumé, because the degrees are more easily read, and a difference of a quarter, or even a half degree, does not make as much difference as the same error on Beaumé's scale. But since it is a trade custom to use the latter hydrometer, a definite understanding of its value is very important.

The boiling points given are after the figures of Dalton. The specific gravity of Sulfuric Acid in the accompanying table is that obtained at a temperature of 60° Fahrenheit (15.5 Celsius). The number of degrees Fahrenheit causing a rise or fall of one degree Beaumé is given in the last column. Thus a rise or fall of forty degrees Fahrenheit in the temperature of acid ranging from sixty to sixty-six degrees Beaumé (at 60° Fahrenheit), causes a fall or rise of one degree Beaumé. In other words, acid of 63° Beaumé at 60° Fahrenheit will stand 62° at 100° Fahrenheit; or it will stand at 64° at a temperature of 80° Fahrenheit, and so on for each set of figures given in the last column.

The term O. V. in the table is the contraction of "Oil of Vitriol," or acid of 93.5 per cent. of H^2SO^4 . The term 60° acid means acid containing 77.6 per cent. H^2SO^4 .

Degrees Beaumé.	Specific gravity.	Per cent. H^2SO^4 .	Per cent. O. V.	Weight of cubic foot.	Per cent. 60° acid.	Pounds of O. V. in cubic foot.	Pounds of 60° acid in cubic foot.	Nearest degree of Twaddell.	Boiling point deg. Celsius.	Boiling point degrees Fah.	Correction for temp.
1	1.005	0.93	1	62.8	0.73	0.62	0.45	1.0	..	..	..
2	1.011	1.87	2	63.2	1.46	1.26	0.92	2.0	..	..	..
3	1.023	3.74	4	63.9	2.92	2.55	1.86	4.5	..	..	..
4	1.029	4.67	5	64.3	3.64	3.21	2.33	5.7	..	..	..
5	1.036	5.61	6	64.7	4.37	3.88	2.83	7.0	..	..	..
6	1.043	6.54	7	65.2	5.10	4.51	3.32	8.5	..	..	..
7	1.050	7.48	8	65.6	5.83	5.25	3.82	10.0	..	..	..
8	1.057	8.41	9	66.0	6.56	5.94	4.33	11.5	..	..	..
9	1.064	9.35	10	66.5	7.29	6.65	4.85	13.0	..	..	..
10	1.071	10.28	11	66.9	8.02	7.36	5.37	14.0	..	..	43°
11	1.086	12.15	13	67.8	15.45	8.81	10.47	17.0	..	..	..
12	1.093	13.09	14	68.3	16.75	9.56	11.44	18.5	..	..	..
13	1.100	14.02	15	68.7	17.94	10.30	12.32	20.0	103	217	..
14	1.107	14.96	16	69.2	19.15	11.07	13.25	21.5	..	..	..
15	1.114	15.89	17	69.6	20.34	11.83	14.15	23.0	..	..	..
16	1.122	16.83	18	70.1	21.54	12.62	15.10	24.5	..	..	..
17	1.136	18.70	20	71.0	23.93	14.20	16.99	27.0	..	..	..

17—Continued.

Degrees Reaumé.	Specific gravity.	Per cent. H ₂ SO ₄ .	Per cent. O. V.	Weight of cubic foot.	Per cent. 60° acid.	Pounds of O. V. in cubic foot.	Pounds of 60° acid in cubic foot.	Nearest degree of Twaddell.	Boiling point deg. Celsius.	Boiling point degrees Fah.	Correction for temp.
18	1.143	19.63	21	71.4	25.12	14.99	17.93	28.5	..	..	..
19	1.150	20.57	22	71.8	26.33	15.79	18.90	30.0	..	..	..
20	1.158	21.50	23	72.3	27.52	16.63	19.89	31.5	..	..	30°
21	1.172	23.37	25	73.2	29.91	18.30	21.89	34.5	..	..	..
22	1.179	24.31	26	73.7	31.11	19.16	22.93	35.7	..	..	..
23	1.186	25.24	27	74.1	32.31	20.00	23.94	37.0	..	..	..
24	1.201	27.11	29	75.0	34.70	21.75	26.02	40.0	107	224	..
25	1.208	28.05	30	75.5	35.90	22.65	27.10	41.5	..	..	..
26	1.216	29.98	31	76.0	37.15	23.56	28.23	43.0	..	..	..
27	1.231	30.85	33	76.9	39.55	25.37	30.41	46.0	..	..	..
28	1.238	31.79	34	77.4	40.75	26.31	31.54	47.5	..	..	..
29	1.254	33.66	36	78.4	43.15	28.22	33.83	51.0	..	..	..
30	1.262	34.59	37	78.9	44.34	29.19	34.98	52.5	..	..	30°
31	1.269	35.53	38	79.3	45.55	30.13	36.12	54.0	..	..	..
32	1.285	37.40	40	80.3	47.95	33.12	38.50	57.0	..	..	..
33	1.293	38.33	41	80.8	49.14	34.13	39.70	58.5	115	239	..
34	1.309	40.30	43	81.8	51.54	35.17	42.16	62.0	..	..	..
35	1.317	41.14	44	82.3	52.74	36.21	43.40	63.5	..	..	..
36	1.334	43.01	46	83.4	55.14	38.36	45.98	67.0	..	..	..
37	1.342	43.94	47	83.9	56.33	39.43	47.26	68.5	..	..	..
38	1.359	45.81	49	84.9	58.73	40.75	49.86	72.0	..	..	..
39	1.368	46.75	50	85.5	59.93	42.75	51.24	73.5	..	..	..
40	1.386	48.62	52	86.6	62.33	45.03	53.98	77.0	..	..	31°
41	1.395	49.55	53	87.2	63.52	46.21	55.39	79.0	..	..	..
42	1.413	51.42	55	88.3	65.92	48.56	58.21	82.5	128	262	..
43	1.422	52.36	56	88.9	67.12	49.78	59.67	84.5	..	..	..
44	1.441	54.23	58	90.0	69.52	52.20	62.57	88.0	..	..	..
45	1.451	55.16	59	90.7	70.71	53.51	64.13	90.0	..	..	..
46	1.470	57.03	61	91.9	73.11	56.06	67.19	94.0	..	..	..
47	1.480	57.97	62	92.5	74.32	57.35	68.74	96.0	..	..	..
48	1.500	59.84	64	93.7	76.71	59.97	71.88	100.0	..	..	..
49	1.510	60.77	65	94.4	77.91	61.36	73.55	102.0	..	..	..
50	1.531	62.64	67	95.7	80.31	64.12	76.85	106.0	144	292	38°
51	1.541	63.58	68	96.3	81.51	65.48	78.49	108.0	..	..	..
52	1.562	65.45	70	97.6	83.91	68.32	81.89	112.5	..	..	..
53	1.573	66.38	71	98.3	85.10	69.69	83.65	114.5	..	..	..
54	1.594	68.25	73	99.6	87.50	72.71	87.15	119.0	..	..	..
55	1.616	70.12	75	101.0	89.89	76.05	90.79	123.0	..	..	..
56	1.627	71.06	76	101.7	91.10	77.29	92.65	125.5	..	..	..
57	1.650	72.93	78	103.1	93.50	80.42	96.40	130.0	177	350	..
58	1.661	73.86	79	103.8	94.69	82.00	98.29	132.0	180	354	..
59	1.683	75.73	81	105.2	97.08	85.21	102.13	136.5	186	367	..
60	1.705	77.60	83	106.5	100.00	88.39	106.50	141.0	192	378	40°
61	1.727	79.47	85	107.9	101.88	91.71	109.93	145.5	200	392	..
62	1.747	81.34	87	109.2	104.28	95.00	113.87	149.5	205	401	..
63	1.767	83.21	89	110.4	106.68	98.25	117.77	153.5	217	422	..
64	1.793	86.02	92	112.0	110.28	103.04	123.51	158.5	230	446	..
65	1.814	88.82	95	113.4	113.87	107.73	129.13	163.0	249	480	..
66	1.835	93.50	100	114.7	119.87	114.70	137.49	167.0	272	523	40°

18. SPECIFIC GRAVITY OF ACETIC ACID AT 15° C. (OUDEMANS).

Specific gravity.	Per cent. Acetic Acid.	Specific gravity.	Per cent. Acetic Acid.	Specific gravity.	Per cent. Acetic Acid.	Specific gravity.	Per cent. Acetic Acid.
0.9992	0	1.0363	26	1.0631	52	1.0748	77
1.0007	1	1.0375	27	1.0638	53	1.0748	78
1.0022	2	1.0388	28	1.0646	54	1.0748	79
1.0037	3	1.0400	29	1.0653	55	1.0748	80
1.0052	4	1.0412	30	1.0660	56	1.0747	81
1.0067	5	1.0424	31	1.0666	57	1.0746	82
1.0083	6	1.0436	32	1.0673	58	1.0744	83
1.0098	7	1.0447	33	1.0679	59	1.0742	84
1.0113	8	1.0459	34	1.0685	60	1.0739	85
1.0127	9	1.0470	35	1.0691	61	1.0736	86
1.0142	10	1.0481	36	1.0697	62	1.0731	87
1.0157	11	1.0492	37	1.0702	63	1.0726	88
1.0171	12	1.0503	38	1.0707	64	1.0720	89
1.0185	13	1.0513	39	1.0712	65	1.0713	90
1.0200	14	1.0523	40	1.0717	66	1.0705	91
1.0214	15	1.0533	41	1.0721	67	1.0696	92
1.0228	16	1.0543	42	1.0725	68	1.0686	93
1.0242	17	1.0552	43	1.0729	69	1.0674	94
1.0256	18	1.0562	44	1.0733	70	1.0660	95
1.0270	19	1.0571	45	1.0737	71	1.0644	96
1.0284	20	1.0580	46	1.0740	72	1.0625	97
1.0298	21	1.0589	47	1.0742	73	1.0604	98
1.0311	22	1.0596	48	1.0744	74	1.0580	99
1.0324	23	1.0607	49	1.0746	75	1.0553	100
1.0337	24	1.0615	50	1.0747	76		
1.0350	25	1.0623	51				

19. SPECIFIC GRAVITY OF TARTARIC ACID AT 15° C. (GERLACH).

Specific gravity.	Per cent. C ² H ² O ⁴ .	Specific gravity.	Per cent. C ² H ² O ⁴ .	Specific gravity.	Per cent. C ² H ² O ⁴ .
1.0045	1	1.0969	20	1.2078	40
1.0090	2	1.1072	22	1.2198	42
1.0179	4	1.1175	24	1.2317	44
1.0273	6	1.1282	26	1.2441	46
1.0371	8	1.1393	28	1.2568	48
1.0469	10	1.1505	30	1.2696	50
1.0565	12	1.1615	32	1.2828	52
1.0661	14	1.1726	34	1.2961	54
1.0761	16	1.1840	36	1.3093	(Satu- 56
1.0865	18	1.1959	38	1.3220	rated) 57.9

20. SPECIFIC GRAVITY OF CITRIC ACID AT 15° C. (GERLACH).

Specific gravity.	Per cent. $C^6H^8O^7, H^2O.$	Specific gravity.	Per cent. $C^6H^8O^7, H^2O.$	Specific gravity.	Per cent. $C^6H^8O^7, H^2O.$
1.0074	2.0	1.1060	26.0	1.2103	48.0
1.0149	4.0	1.1152	28.0	1.2204	50.0
1.0227	6.0	1.1244	30.0	1.2307	52.0
1.0309	8.0	1.1333	32.0	1.2410	54.0
1.0392	10.0	1.1422	34.0	1.2514	56.0
1.0470	12.0	1.1515	36.0	1.2627	58.0
1.0549	14.0	1.1612	38.0	1.2738	60.0
1.0632	16.0	1.1709	40.0	1.2849	62.0
1.0718	18.0	1.1814	42.0	1.2960	64.0
1.0806	20.0	1.1899	44.0	1.3071	(Satu- 66.0
1.0889	22.0	1.1998	46.0	1.3076	rated) 66.1
1.0972	24.0				

21. SPECIFIC GRAVITY OF TANNIC ACID AT 15° C. (TRAUBER).

Specific gravity.	Per cent. Tannic Acid	Specific gravity.	Per cent. Tannic Acid	Specific gravity.	Per cent. Tannic Acid
1.0040	1.0	1.0096	2.4	1.0153	3.8
1.0044	1.1	1.0100	2.5	1.0156	3.9
1.0048	1.2	1.0104	2.6	1.0160	4.0
1.0052	1.3	1.0108	2.7	1.0164	4.1
1.0056	1.4	1.0112	2.8	1.0168	4.2
1.0060	1.5	1.0116	2.9	1.0172	4.3
1.0064	1.6	1.0120	3.0	1.0176	4.4
1.0068	1.7	1.0124	3.1	1.0180	4.5
1.0072	1.8	1.0128	3.2	1.0184	4.6
1.0076	1.9	1.0132	3.3	1.0188	4.7
1.0080	2.0	1.0136	3.4	1.0192	4.8
1.0084	2.1	1.0140	3.5	1.0196	4.9
1.0088	2.2	1.0144	3.6	1.0200	5.0
1.0092	2.3	1.0148	3.7		

C.—SALTS.**22. SPECIFIC GRAVITY OF SOLUTIONS OF SODIUM CHLORIDE AT + 15° C.**

Specific gravity.	Per cent. NaCl	Specific gravity.	Per cent. NaCl	Specific gravity.	Per cent. NaCl.
1.00725	1.0	1.07335	10.0	1.14315	19.0
1.01450	2.0	1.08097	11.0	1.15107	20.0
1.02174	3.0	1.08859	12.0	1.15931	21.0
1.02899	4.0	1.09623	13.0	1.16755	22.0
1.03624	5.0	1.10384	14.0	1.17580	23.0
1.04366	6.0	1.11146	15.0	1.18404	24.0
1.05108	7.0	1.11908	16.0	1.19228	25.0
1.05851	8.0	1.12730	17.0	1.20098	26.0
1.06593	9.0	1.13523	18.0	1.20433	26.395

23. SPECIFIC GRAVITY OF SOLUTIONS OF AMMONIUM CHLORIDE
AT +15° C.

Specific gravity.	Per cent. NH ₄ Cl.	Specific gravity.	Per cent. NH ₄ Cl.	Specific gravity.	Per cent. NH ₄ Cl.
1.00816	1.0	1.03081	10.0	1.05648	19.0
1.00633	2.0	1.03370	11.0	1.05929	20.0
1.00948	3.0	1.03658	12.0	1.06204	21.0
1.01264	4.0	1.03947	13.0	1.06479	22.0
1.01580	5.0	1.04225	14.0	1.06754	23.0
1.01890	6.0	1.04524	15.0	1.07029	24.0
1.02160	7.0	1.04805	16.0	1.07304	25.0
1.02481	8.0	1.05088	17.0	1.07575	26.0
1.02781	9.0	1.05367	18.0	1.07658	26.297

24. SPECIFIC GRAVITY OF SOLUTIONS OF CALCIUM CHLORIDE
AT 18.3° (SCHIFF).

Specific gravity.	Per cent. CaCl ₂ +6H ₂ O	Per cent. CaCl ₂ .	Specific gravity.	Per cent. CaCl ₂ +6H ₂ O	Per cent. CaCl ₂ .
1.0039	1	0.507	1.1575	36	18.245
1.0079	2	1.014	1.1622	37	18.752
1.0119	3	1.521	1.1671	38	19.259
1.0159	4	2.028	1.1719	39	19.766
1.0200	5	2.534	1.1768	40	20.272
1.0241	6	3.041	1.1816	41	20.779
1.0282	7	3.548	1.1865	42	21.286
1.0323	8	4.055	1.1914	43	21.793
1.0365	9	4.562	1.1963	44	22.300
1.0407	10	5.068	1.2012	45	22.806
1.0449	11	5.575	1.2062	46	23.313
1.0491	12	6.082	1.2112	47	23.820
1.0534	13	6.587	1.2162	48	24.327
1.0577	14	7.096	1.2212	49	24.834
1.0619	15	7.601	1.2262	50	25.340
1.0663	16	8.107	1.2312	51	25.847
1.0706	17	8.611	1.2363	52	26.354
1.0750	18	9.121	1.2414	53	26.861
1.0794	19	9.625	1.2465	54	27.368
1.0838	20	10.136	1.2516	55	27.874
1.0882	21	10.643	1.2567	56	28.381
1.0927	22	11.150	1.2618	57	28.888
1.0972	23	11.657	1.2669	58	29.395
1.1017	24	12.164	1.2721	59	29.902
1.1062	25	12.670	1.2773	60	30.408
1.1107	26	13.177	1.2825	61	30.915
1.1153	27	13.684	1.2877	62	31.422
1.1199	28	14.191	1.2929	63	31.929
1.1246	29	14.698	1.2981	64	32.436
1.1292	30	15.204	1.3034	65	32.942
1.1339	31	15.711	1.3087	66	33.449
1.1386	32	16.218	1.3140	67	33.956
1.1433	33	16.725	1.3193	68	34.463
1.1480	34	17.232	1.3246	69	34.970
1.1527	35	17.738	1.3300	70	35.476

25. STRENGTH OF SOLUTIONS OF CALCIUM HYPOCHLORITE (BLEACHING POWDER).

French degrees.	Per cent. Chlorin.	French degrees.	Per cent. Chlorin.	French degrees.	Per cent. Chlorin.
63	20.02	85	27.01	107	34.00
64	20.84	86	27.33	108	34.32
65	20.65	87	27.65	109	34.64
66	20.97	88	27.96	110	34.95
67	21.29	89	28.28	111	35.27
68	21.61	90	28.60	112	35.59
69	21.93	91	28.92	113	35.91
70	22.24	92	29.23	114	36.22
71	22.56	93	29.55	115	36.54
72	22.88	94	29.87	116	36.86
73	23.20	95	30.19	117	37.18
74	23.51	96	30.51	118	37.50
75	23.83	97	30.82	119	37.81
76	24.15	98	31.14	120	38.13
77	24.47	99	31.46	121	38.45
78	24.79	100	31.78	122	38.77
79	25.10	101	32.09	123	39.08
80	25.42	102	32.41	124	39.40
81	25.74	103	32.73	125	39.72
82	26.06	104	33.05	126	40.04
83	26.37	105	33.36	127	40.36
84	26.69	106	33.68	128	40.67

French degrees give the number of liters of chlorine developed from 1 kilogram bleaching powder at 0° C. and 760 mm. pressure. The degrees used in the United States, England, Germany and Russia, express the quantity of available chlorine by weight contained in 100 parts of bleaching powder (1 liter Cl = 3.1776 g. at 0° C. and 760 mm.).

26. SPECIFIC GRAVITY OF SOLUTIONS OF MAGNESIUM CHLORIDE AT 24° C. (SCHIFF).

Specific gravity.	Per cent. $MgCl^2 + 6H^2O$	Per cent. $MgCl^2$	Specific gravity.	Per cent. $MgCl^2 + 6H^2O$	Per cent. $MgCl^2$
1.0069	2	0.936	1.1519	42	19.656
1.0138	4	1.872	1.1598	44	20.592
1.0207	6	2.808	1.1677	46	21.528
1.0276	8	3.744	1.1756	48	22.464
1.0345	10	4.680	1.1836	50	23.400
1.0415	12	5.616	1.1918	52	24.336
1.0485	14	6.552	1.2000	54	25.272
1.0556	16	7.488	1.2083	56	26.208
1.0627	18	8.424	1.2167	58	27.144
1.0698	20	9.360	1.2252	60	28.080
1.0770	22	10.296	1.2338	62	29.016
1.0842	24	11.232	1.2425	64	29.952
1.0915	26	12.168	1.2513	66	30.888
1.0988	28	13.104	1.2602	68	31.824
1.1062	30	14.040	1.2692	70	32.760
1.1137	32	14.976	1.2783	72	33.696
1.1212	34	15.912	1.2875	74	34.632
1.1288	36	16.848	1.2968	76	35.568
1.1364	38	17.784	1.3063	78	36.504
1.1441	40	18.720	1.3159	80	37.440

**27. SPECIFIC GRAVITY OF SOLUTIONS OF ALUMINUM CHLORIDE
AT 15° C. (GERLACH).**

Specific gravity.	Per cent. Al^3Cl^3	Specific gravity.	Per cent. Al^3Cl^3	Specific gravity.	Per cent. Al^3Cl^3
1.00721	1	1.11248	15	1.23310	29
1.01443	2	1.12078	16	1.24219	30
1.02164	3	1.12897	17	1.25184	31
1.02885	4	1.13721	18	1.26149	32
1.03603	5	1.14545	19	1.27115	33
1.04353	6	1.15370	20	1.28080	34
1.05099	7	1.16231	21	1.29046	35
1.05845	8	1.17092	22	1.30066	36
1.06591	9	1.17.53	23	1.31066	37
1.07337	10	1.18815	24	1.32106	38
1.08120	11	1.19676	25	1.33126	39
1.08902	12	1.20584	26	1.34146	40
1.09684	13	1.21493	27	1.35224	41
1.10466	14	1.22406	28	1.35359	41.126

28. SPECIFIC GRAV. OF SOLUTIONS OF IRON CHLORIDE AT 17.5° C. (FRANZ).

Specific gravity.	Per cent. Fe^3Cl^3	Specific gravity.	Per cent. Fe^3Cl^3	Specific gravity.	Per cent. Fe^3Cl^3
1.0146	2	1.1746	22	1.3870	42
1.0292	4	1.1950	24	1.4118	44
1.0439	6	1.2155	26	1.4367	46
1.0587	8	1.2365	28	1.4617	48
1.0734	10	1.2568	30	1.4867	50
1.0894	12	1.2778	32	1.5153	52
1.1054	14	1.2988	34	1.5439	54
1.1215	16	1.3199	36	1.5729	56
1.1378	18	1.3411	38	1.6023	58
1.1542	20	1.3623	40	1.6317	60

**29. SPECIFIC GRAVITY OF SOLUTIONS OF STANNOUS CHLORIDE
 $SnCl^2$ (TIN CRYSTALS) AT 15° C. (GERLACH).**

Specific grav.	Per cent. $SnCl^2+2H^2O$	Specific grav.	Per cent. $SnCl^2+2H^2O$	Specific grav.	Per cent. $SnCl^2+2H^2O$
1.013	2	1.212	28	1.497	54
1.026	4	1.230	30	1.525	56
1.040	6	1.249	32	1.554	58
1.054	8	1.268	34	1.582	60
1.068	10	1.288	36	1.613	62
1.083	12	1.309	38	1.644	64
1.097	14	1.330	40	1.677	66
1.113	16	1.352	42	1.711	68
1.128	18	1.374	44	1.745	70
1.144	20	1.397	46	1.783	72
1.161	22	1.421	48	1.821	74
1.177	24	1.445	50	1.840	75
1.194	26	1.471	52		

30. SPECIFIC GRAVITY OF SOLUTIONS OF STANNIC CHLORIDE
(SnCl_4) AT 15° C. (GERLACH).

Specific grav.	Per cent. $\text{Sn Cl}_4 + 5\text{H}_2\text{O}$	Specific grav.	Per cent. $\text{Sn Cl}_4 + 5\text{H}_2\text{O}$	Specific grav.	Per cent. $\text{Sn Cl}_4 + 5\text{H}_2\text{O}$
1.012	2	1.2268	34	1.538	66
1.024	4	1.242	36	1.563	68
1.036	6	1.259	38	1.587	70
1.048	8	1.2755	40	1.614	72
1.059	10	1.293	42	1.641	74
1.072	12	1.310	44	1.669	76
1.084	14	1.329	46	1.696	78
1.097	16	1.347	48	1.727	80
1.110	18	1.366	50	1.759	82
1.1236	20	1.386	52	1.791	84
1.137	22	1.406	54	1.824	86
1.151	24	1.426	56	1.859	88
1.165	26	1.447	58	1.893	90
1.180	28	1.468	60	1.932	92
1.195	30	1.491	62	1.969	94
1.210	32	1.514	64	1.988	96

31. SPECIFIC GRAVITY OF SOLUTIONS OF POTASSIUM NITRATE
(SALTPETER) AT 21° C.

Specific gravity.	Per cent. KNO_3 .	Specific gravity.	Per cent. KNO_3 .	Specific gravity.	Per cent. KNO_3 .
1.0058	1	1.0555	9	1.1097	17
1.0118	2	1.0621	10	1.1160	18
1.0178	3	1.0686	11	1.1242	19
1.0239	4	1.0752	12	1.1316	20
1.0300	5	1.0819	13	1.1390	21
1.0363	6	1.0887	14	1.1464	22
1.0425	7	1.0956	15	1.1539	23
1.0490	8	1.1026	16	1.1618	24

32. SPECIFIC GRAVITY OF SOLUTIONS OF SODIUM NITRATE
(CHILE-SALTPETER) AT 25.2° C.

Specific grav.	Per cent. NaNO_3	Specific grav.	Per cent. NaNO_3	Specific grav.	Per cent. NaNO_3	Specific grav.	Per cent. NaNO_3
1.0065	1	1.0962	14	1.1987	27	1.3055	39
1.0181	2	1.1035	15	1.2070	28	1.3155	40
1.0197	3	1.1109	16	1.2154	29	1.3255	41
1.0264	4	1.1184	17	1.2239	30	1.3355	42
1.0333	5	1.1260	18	1.2325	31	1.3456	43
1.0399	6	1.1338	19	1.2412	32	1.3557	44
1.0468	7	1.1418	20	1.2500	33	1.3659	45
1.0537	8	1.1496	21	1.2589	34	1.3761	46
1.0606	9	1.1578	22	1.2679	35	1.3864	47
1.0676	10	1.1659	23	1.2770	36	1.3968	48
1.0746	11	1.1740	24	1.2863	37	1.4074	49
1.0817	12	1.1822	25	1.2958	38	1.4180	50
1.0889	13	1.1904	26				

33. SPECIFIC GRAVITY OF SOLUTIONS OF AMMONIUM NITRATE
AT 17.5° C. (GERLACH).

Specific gravity.	Per cent. NH_4NO_3	Specific gravity.	Per cent. NH_4NO_3	Specific gravity.	Per cent. NH_4NO_3
1.0000	0	1.1310	30	1.2300	50
1.0425	10	1.1790	40	1.2335	60
1.0860	20				

34. SPECIFIC GRAVITY OF SOLUTIONS OF IRON NITRATE
AT 17.5° C. (FRANZ).

Specific gravity.	Per cent. $\text{Fe}^2(\text{NO}_3)_6$	Specific gravity.	Per cent. $\text{Fe}^2(\text{NO}_3)_6$	Specific gravity.	Per cent. $\text{Fe}^2(\text{NO}_3)_6$
1.0770	10	1.2622	30	1.4972	50
1.1612	20	1.3746	40	1.6572	60

35. SPECIFIC GRAVITY OF SOLUTIONS OF SILVER NITRATE
AT 17.5° C. (FRANZ).

Specific gravity.	Per cent. AgNO_3	Specific gravity.	Per cent. AgNO_3	Specific gravity.	Per cent. AgNO_3
1.041	5	1.080	10	1.160	20
1.050	6	1.100	12	1.206	25
1.058	7	1.125	15	1.251	30
1.064	8	1.150	18		

36. SPECIFIC GRAVITY OF SOLUTIONS OF SODIUM ACETATE
AT 17.5° C. (GERLACH).

Specific grav.	Per cent. $\text{NaC}^2\text{H}^3\text{O}^2$	Per cent. $\text{NaC}^2\text{H}^3\text{O}^2 + 8\text{H}^2\text{O}$	Specific grav.	Per cent. $\text{NaC}^2\text{H}^3\text{O}^2$	Per cent. $\text{NaC}^2\text{H}^3\text{O}^2 + 8\text{H}^2\text{O}$
1.0000	0	0	1.047	9.045	15
1.015	3.015	5	1.063	12.060	20
1.031	6.030	10	1.0795	19.075	25

37. SPECIFIC GRAVITY OF SOLUTIONS OF POTASSIUM ACETATE
AT 17.5° C. (GERLACH).

Specific gravity.	Per cent. $\text{KC}^2\text{H}^3\text{O}^2$	Specific gravity.	Per cent. $\text{KC}^2\text{H}^3\text{O}^2$	Specific gravity.	Per cent. $\text{KC}^2\text{H}^3\text{O}^2$
1.0000	0	1.1545	30	1.2685	50
1.0490	10	1.2105	40	1.3235	60
1.1005	20				

38. SPECIFIC GRAVITY OF SOLUTIONS OF SODIUM SULFATE AT 19° C.

Specific gravity.	Per cent. $\text{Na}^2\text{SO}^4 + 10 \text{ Aq.}$	Per cent. Na^2SO^4	Specific gravity.	Per cent. $\text{Na}^2\text{SO}^4 + 10 \text{ Aq.}$	Per cent. Na^2SO^4
1.0040	1	0.441	1.0643	16	7.056
1.0079	2	0.881	1.0683	17	7.497
1.0118	3	1.323	1.0725	18	7.938
1.0158	4	1.764	1.0766	19	8.379
1.0198	5	2.205	1.0807	20	8.820
1.0238	6	2.646	1.0849	21	9.261
1.0278	7	3.087	1.0890	22	9.702
1.0318	8	3.528	1.0931	23	10.143
1.0358	9	3.969	1.0973	24	10.584
1.0398	10	4.410	1.1015	25	11.025
1.0439	11	4.851	1.1057	26	11.466
1.0479	12	5.292	1.1100	27	11.907
1.0520	13	5.733	1.1142	28	12.348
1.0560	14	6.174	1.1184	29	12.789
1.0601	15	6.615	1.1226	30	13.230

39. SPECIFIC GRAVITY OF SOLUTIONS OF POTASSIUM SULFATE AT 15° C. (GERLACH).

Specific grav.	Per cent. K^2SO^4	Specific grav.	Per cent. K^2SO^4
1.00820	1.0	1.04947	6.0
1.01635	2.0	1.05790	7.0
1.02450	3.0	1.06644	8.0
1.03277	4.0	(Satu-1.07499	9.0
1.04105	5.0	rated) 1.08305	9.92

40. SPECIFIC GRAVITY OF SOLUTIONS OF POTASH-ALUM AT 17.5° C. (GERLACH).

Specific gravity.	Per cent. $\text{Al}^3\text{K}^2(\text{SO}^4)^3$	Per cent. $\text{Al}^3\text{K}^2(\text{SO}^4)^3 + 24\text{H}^2\text{O}$	Specific gravity.	Per cent. $\text{Al}^3\text{K}^2(\text{SO}^4)^3$	Per cent. $\text{Al}^3\text{K}^2(\text{SO}^4)^3 + 24\text{H}^2\text{O}$
1.0205	2.1792	4	1.0635	6.5379	12
1.0415	4.3548	8	1.0690	7.0824	13

41. SPECIFIC GRAVITY OF SOLUTIONS OF CHROME-ALUM AT 17.5° C. (FRANZ).

Per cent. $\text{K}^2\text{Cr}^2(\text{SO}^4)^3 + 24 \text{ Aq.}$	Specific gravity.	Per cent. $\text{K}^2\text{Cr}^2(\text{SO}^4)^3 + 24 \text{ Aq.}$	Specific gravity.
5	1.0174	40	1.1896
10	1.0342	50	1.2204
20	1.0746	60	1.4566
30	1.1274	70	1.6362

**42. SPECIFIC GRAVITY OF SOLUTIONS OF POTASSIUM TARTRATE
AT 17.5° C. (GERLACH).**

Specific gravity.	Per cent. $K^2C^4H^4O^6$	Specific gravity.	Per cent. $K^2C^4H^4O^6$	Specific gravity.	Per cent. $K^2C^4H^4O^6$
1.0000	0	1.1850	20	1.2930	40
1.0650	10	1.2110	30	1.3815	50

**43. SPECIFIC GRAVITY OF SOLUTIONS OF POTASSIUM AND SODIUM
TARTRATE AT 17.5° C. (GERLACH).**

Spec. grav.	Per cent. $NaKC^4H^4O^6$	$NaKC^4H^4O^6 + 4H^2O$	Spec. grav.	Per cent. $NaKC^4H^4O^6$	$NaKC^4H^4O^6 + 4H^2O$
1.0000	0	0	1.1620	22.344	30
1.0510	7.448	10	1.2230	29.729	40
1.1050	14.896	20	1.2890	37.240	50

**44. SPECIFIC GRAVITY OF SOLUTIONS OF IRON SULFATE
AT 15° C.**

Specific gravity.	Per cent. $FeSO^4 + 7H^2O$	Specific gravity.	Per cent. $FeSO^4 + 7H^2O$
1.011	2	1.082	15
1.021	4	1.112	20
1.032	6	1.143	25
1.043	8	1.174	30
1.054	10	1.206	35
1.065	12	1.239	40

**45. SPECIFIC GRAVITY OF SOLUTIONS OF COPPER SULFATE
AT 15° C.**

Specific gravity.	Per cent. $CuSO^4 + 5H^2O$	Specific gravity.	Per cent. $CuSO^4 + 5H^2O$
1.0126	2	1.0933	14
1.0254	4	1.1063	16
1.0384	6	1.1208	18
1.0516	8	1.1354	20
1.0649	10	1.1501	22
1.0785	12	1.1659	24

**46. SPECIFIC GRAVITY OF SOLUTIONS OF POTASSIUM FERROCYANIDE
AT 15° C.**

Specific grav.	Per cent. $K^4Fe(CN)^6 + 3H^2O$	Per cent. $K^4Fe(CN)^6$	Specific grav.	Per cent. $K^4Fe(CN)^6 + 3H^2O$	Per cent. $K^4Fe(CN)^6$
1.0068	1	0.872	1.0669	11	9.592
1.0116	2	1.744	1.0734	12	10.464
1.0175	3	2.616	1.0800	13	11.336
1.0234	4	3.488	1.0866	14	12.208
1.0295	5	4.360	1.0932	15	13.080
1.0356	6	5.232	1.0999	16	13.952
1.0417	7	6.104	1.1067	17	14.824
1.0479	8	6.976	1.1136	18	15.696
1.0542	9	7.848	1.1205	19	16.568
1.0605	10	8.720	1.1275	20	17.440

**47. SPECIFIC GRAVITY OF SOLUTIONS OF POTASSIUM FERRICYANIDE
AT 15° C.**

Specific grav.	Per cent. $K^6Fe^3(CN)^{12}$	Specific grav.	Per cent. $K^6Fe^3(CN)^{12}$	Specific grav.	Per cent. $K^6Fe^3(CN)^{12}$
1.0051	1	1.0426	8	1.1139	20
1.0108	2	1.0482	9	1.1266	22
1.0155	3	1.0538	10	1.1396	24
1.0206	4	1.0593	12	1.1529	26
1.0261	5	1.0771	14	1.1664	28
1.0315	6	1.0891	16	1.1802	30
1.0370	7	1.1014	18		

**48. SPECIFIC GRAVITY OF SOLUTIONS OF POTASSIUM CHROMATE
AT 19.5° C. (SCHIFF).**

Specific grav.	Per cent. K^2CrO^4	Specific grav.	Per cent. K^2CrO^4	Specific grav.	Per cent. K^2CrO^4	Specific grav.	Per cent. K^2CrO^4
1.0080	1	1.0925	11	1.1864	21	1.2921	31
1.0161	2	1.1014	12	1.1964	22	1.3035	32
1.0243	3	1.1104	13	1.2066	23	1.3151	33
1.0325	4	1.1195	14	1.2169	24	1.3268	34
1.0408	5	1.1287	15	1.2274	25	1.3386	35
1.0492	6	1.1380	16	1.2379	26	1.3505	36
1.0576	7	1.1474	17	1.2485	27	1.3625	37
1.0663	8	1.1570	18	1.2592	28	1.3746	38
1.0750	9	1.1667	19	1.2700	29	1.3868	39
1.0837	10	1.1765	20	1.2808	30	1.3991	40

**49. SPECIFIC GRAVITY OF SOLUTIONS OF POTASSIUM BICHROMATE
AT 19.5° C.**

Specific gravity.	Per cent. $K^2Cr^2O^7$
1.0405	5.781
1.0647	11.583

50. SPECIFIC GRAVITY OF SOLUTIONS OF SODIUM BICHROMATE (STANLEY).

Specific gravity.	Per cent. $\text{Na}^2\text{Cr}^2\text{O}^7$	Specific gravity.	Per cent. $\text{Na}^2\text{Cr}^2\text{O}^7$
1.007	1	1.171	25
1.085	5	1.208	30
1.071	10	1.230	40
1.105	15	1.313	45
1.141	20	1.343	50

51. SPECIFIC GRAVITY OF SOLUTIONS OF SODIUM THIO-SULFATE AT 19° C. (SCHIFF).

Specific gravity.	Per cent. $\text{Na}^2\text{S}^2\text{O}^3$ + 5 Aq.	Per cent. $\text{Na}^2\text{S}^2\text{O}^3$	Specific gravity.	Per cent. $\text{Na}^2\text{S}^2\text{O}^3$ + 5 Aq.	Per cent. $\text{Na}^2\text{S}^2\text{O}^3$	Specific gravity.	Per cent. $\text{Na}^2\text{S}^2\text{O}^3$ + 5 Aq.	Per cent. $\text{Na}^2\text{S}^2\text{O}^3$
1.0052	1	0.637	1.0975	18	11.467	1.1996	35	22.236
1.0105	2	1.274	1.1031	19	12.105	1.2048	36	22.935
1.0158	3	1.911	1.1087	20	12.742	1.2110	37	23.572
1.0211	4	2.548	1.1145	21	13.379	1.2172	38	24.209
1.0264	5	3.185	1.1204	22	14.016	1.2234	39	24.846
1.0317	6	3.822	1.1263	23	14.653	1.2297	40	25.484
1.0370	7	4.459	1.1322	24	15.290	1.2362	41	26.121
1.0423	8	5.096	1.1381	25	15.927	1.2427	42	26.758
1.0476	9	5.733	1.1440	26	16.564	1.2492	43	27.395
1.0529	10	6.371	1.1499	27	17.201	1.2558	44	28.032
1.0582	11	7.008	1.1558	28	17.838	1.2624	45	28.669
1.0639	12	7.645	1.1617	29	18.475	1.2690	46	29.306
1.0695	13	8.282	1.1676	30	19.112	1.2756	47	29.943
1.0751	14	8.919	1.1738	31	19.750	1.2822	48	30.580
1.0807	15	9.556	1.1800	32	20.387	1.2888	49	31.218
1.0863	16	10.193	1.1862	33	21.024	1.2954	50	31.855
1.0919	17	10.830	1.1924	34	21.661			

52. SPECIFIC GRAVITY OF SOLUTIONS OF POTASSIUM CARBONATE AT 15° C. (LUNGE).

Specific gravity.	Beaumé.	Twaddell	Per cent. K^2CO^3	1 cubic meter contains kilograms K^2CO^3	Specific gravity.	Beaumé.	Twaddell	Per cent. K^2CO^3	1 cubic meter contains kilograms K^2CO^3
1.007	1	1.4	0.7	7	1.075	10	15.0	8.1	87
1.014	2	2.8	1.5	15	1.083	11	16.6	9.0	97
1.022	3	4.4	2.3	23	1.091	12	19.2	9.8	107
1.029	4	5.8	3.1	32	1.100	13	20.0	10.7	118
1.037	5	7.4	4.0	41	1.108	14	21.6	11.6	129
1.045	6	9.0	4.9	51	1.116	15	23.2	12.4	138
1.052	7	10.4	5.7	60	1.125	16	25.0	13.3	150
1.060	8	12.0	6.5	69	1.134	17	26.8	14.2	161
1.067	9	13.4	7.3	78	1.142	18	28.4	15.0	171

52—Continued.

Specific gravity.	Beaumé.	Twaddell	Per cent. K_2CO_3	1 cubic meter contains kilograms K_2CO_3	Specific gravity.	Beaumé.	Twaddell	Per cent. K_2CO_3	1 cubic meter contains kilograms K_2CO_3
1.152	19	30.4	16.0	184	1.332	36	66.4	32.7	436
1.162	20	32.4	17.0	196	1.345	37	69.0	33.8	455
1.172	21	34.4	18.0	211	1.357	38	71.4	34.8	472
1.180	22	36.0	18.8	222	1.370	39	74.0	35.9	492
1.190	23	38.0	19.7	234	1.383	40	76.6	37.0	512
1.200	24	40.0	20.7	248	1.397	41	79.4	38.2	534
1.210	25	42.0	21.6	261	1.410	42	82.0	39.3	554
1.220	26	44.0	22.5	275	1.424	43	84.8	40.5	577
1.231	27	46.2	23.5	289	1.438	44	87.6	41.7	600
1.241	28	48.2	24.5	304	1.453	45	90.6	42.8	622
1.252	29	50.4	25.5	319	1.468	46	93.6	44.0	646
1.263	30	52.6	26.6	336	1.483	47	96.6	45.2	670
1.274	31	54.8	27.5	350	1.498	48	99.6	46.5	697
1.285	32	57.0	28.5	366	1.514	49	102.8	47.7	722
1.297	33	59.4	29.6	384	1.530	50	106.0	48.9	748
1.308	34	61.6	30.7	402	1.546	51	109.2	50.1	775
1.320	35	64.0	31.6	417	1.563	52	112.6	51.3	802

53. SPECIFIC GRAVITY OF SOLUTIONS OF SODIUM CARBONATE AT 15° C. (LUNGE).

Spec. grav.	Beaumé.	Twaddell.	Per cent. by weight.		1 cubic meter contains kilograms.	
			Na_2CO_3	Na_2CO_3 , 10 Aq.	Na_2CO_3	Na_2CO_3 , 10 Aq.
1.007	1	1.4	0.67	1.807	6.8	18.2
1.014	2	2.8	1.33	3.587	13.5	36.4
1.022	3	4.1	2.09	5.637	21.4	57.6
1.029	4	5.8	2.76	7.444	28.4	76.6
1.036	5	7.2	3.43	9.251	35.5	95.8
1.045	6	9.0	4.29	11.570	44.8	120.9
1.052	7	10.4	4.94	13.323	52.0	140.2
1.060	8	12.0	5.71	15.400	60.5	163.2
1.067	9	13.4	6.37	17.180	68.0	183.3
1.075	10	15.0	7.12	19.203	76.5	206.4
1.083	11	16.6	7.88	21.252	85.3	230.2
1.091	12	18.2	8.62	23.218	94.0	253.6
1.100	13	20.0	9.43	25.432	103.7	279.8
1.108	14	21.6	10.19	27.482	112.9	304.5
1.116	15	23.2	10.95	29.532	122.2	329.6
1.125	16	25.0	11.81	31.851	132.9	358.3
1.134	17	26.8	12.61	34.009	143.0	385.7
1.142	18	28.4	13.46	35.493	150.3	405.3
1.152	19	30.4	14.24	38.405	164.1	442.4

54. SPECIFIC GRAVITY OF CONCENTRATED SOLUTIONS OF SODIUM CARBONATE AT 30° C. (LUNGE).

A.

Specific gravity 30° C.	Degrees Twaddell	Per cent. by weight.		1 liter contains grams.	
		Na ² CO ³	Na ² CO ³ , 10 Aq.	Na ² CO ³	Na ² CO ³ , 10 Aq.
1.310	63	28.13	75.91	368.5	994.5
1.300	60	27.80	73.67	354.9	957.4
1.290	58	26.46	71.40	341.3	921.0
1.280	56	25.62	69.11	327.9	884.7
1.270	54	24.78	66.86	314.7	849.2
1.260	52	23.93	64.59	301.5	813.2
1.250	50	23.08	62.15	288.5	778.5
1.240	48	22.21	59.94	275.4	743.0
1.230	46	21.33	57.55	262.3	707.8
1.220	44	20.47	55.29	249.7	673.8
1.210	42	19.61	52.91	237.3	640.3
1.200	40	18.76	50.62	225.1	607.4
1.190	38	17.90	48.31	214.0	577.5
1.180	36	17.04	45.97	201.1	542.6
1.170	34	16.18	43.88	189.3	510.9
1.160	32	15.32	41.84	177.7	479.5
1.150	30	14.47	39.04	164.4	449.0
1.140	28	13.62	36.75	155.3	419.0

B.

Specific gravity 30° C.	Degrees Beaumé.	Per cent. by weight.		1 liter contains grams.	
		Na ² CO ³	Na ² CO ³ , 10 Aq.	Na ² CO ³	Na ² CO ³ , 10 Aq.
1.308	34	27.97	75.48	365.9	987.4
1.297	33	27.06	73.02	351.0	947.1
1.285	32	26.04	70.28	334.6	902.8
1.274	31	25.11	67.76	319.9	863.2
1.263	30	24.18	65.24	305.4	824.1
1.252	29	23.25	62.73	291.1	785.4
1.241	28	22.29	60.15	276.6	746.3
1.231	27	21.42	57.80	263.7	711.5
1.220	26	20.47	55.29	249.7	673.8
1.210	25	19.61	52.91	237.3	640.3
1.200	24	18.76	50.62	225.1	607.4
1.190	23	17.90	48.31	214.0	577.5
1.180	22	17.04	45.97	201.1	542.6
1.171	21	16.27	43.89	190.5	514.0
1.162	20	15.49	41.79	180.0	485.7
1.152	19	14.64	39.51	168.7	455.2
1.142	18	13.79	37.21	157.5	425.0

55. VARIOUS EXPRESSIONS FOR ALKALINE STRENGTH.

Gay-Lussac degrees Na ₂ O	German degrees Na ₂ CO ₃	English degrees Na ₂ O	Desorziilles degrees H ₂ SO ₄	Gay-Lussac degrees Na ₂ O	German degrees Na ₂ CO ₃	English degrees Na ₂ O	Desorziilles degrees H ₂ SO ₄
0.5	0.85	0.51	0.79	24.5	41.89	24.82	38.72
1.0	1.71	1.01	1.58	25.0	42.75	25.33	39.51
1.5	2.56	1.52	2.37	25.5	43.60	25.83	40.30
2.0	2.42	2.03	3.16	26.0	44.46	26.34	41.09
2.5	4.27	2.54	3.95	26.5	45.31	26.85	41.88
3.0	5.13	3.04	4.74	27.0	46.17	27.35	42.67
3.5	5.98	3.55	5.53	27.5	47.02	27.86	43.46
4.0	6.84	4.05	6.32	28.0	47.88	28.36	44.25
4.5	7.69	4.56	7.11	28.5	48.73	28.87	45.04
5.0	8.55	5.06	7.90	29.0	49.59	29.38	45.83
5.5	9.40	5.57	8.69	29.5	50.44	29.89	46.62
6.0	10.26	6.08	9.48	30.0	51.29	30.39	47.42
6.5	11.11	6.59	10.27	30.5	52.14	30.90	48.21
7.0	11.97	7.09	11.06	31.0	53.00	31.41	49.00
7.5	12.82	7.60	11.85	31.5	53.85	31.91	49.79
8.0	13.68	8.10	12.64	32.0	54.71	32.42	50.58
8.5	14.53	8.61	13.43	32.5	55.56	32.93	51.37
9.0	15.39	9.12	14.22	33.0	56.42	33.44	52.16
9.5	16.24	9.63	15.01	33.5	57.27	33.94	52.95
10.0	17.10	10.13	15.81	34.0	58.13	34.44	53.74
10.5	17.95	10.64	16.60	34.5	58.98	34.95	54.53
11.0	18.81	11.14	17.39	35.0	59.84	35.46	55.32
11.5	19.66	11.65	18.18	35.5	60.69	35.96	56.11
12.0	20.52	12.17	18.97	36.0	61.55	36.47	56.90
12.5	21.37	12.68	19.76	36.5	62.40	36.98	57.69
13.0	22.23	13.17	20.55	37.0	63.26	37.48	58.48
13.5	23.08	13.68	21.34	37.5	64.11	37.99	59.27
14.0	23.94	14.18	22.13	38.0	64.97	38.50	60.06
14.5	24.79	14.69	22.92	38.5	65.82	39.00	60.85
15.0	25.65	15.19	23.71	39.0	66.68	39.51	61.64
15.5	26.50	15.70	24.50	39.5	67.53	40.02	62.43
16.0	27.36	16.21	25.29	40.0	68.39	40.52	63.22
16.5	28.21	16.73	26.08	40.5	69.24	41.03	64.01
17.0	29.07	17.23	26.87	41.0	70.10	41.54	64.81
17.5	29.93	17.73	27.66	41.5	70.95	42.04	65.60
18.0	30.78	18.23	28.45	42.0	71.81	42.55	66.39
18.5	31.63	18.74	29.24	42.5	72.66	43.06	67.18
19.0	32.49	19.25	30.03	43.0	73.53	43.57	67.97
19.5	33.34	19.76	30.82	43.5	74.37	44.07	68.76
20.0	34.20	20.26	31.61	44.0	75.23	44.58	69.55
20.5	35.05	20.77	32.40	44.5	76.08	45.08	70.34
21.0	35.91	21.27	33.19	45.0	76.95	45.59	71.13
21.5	36.76	21.78	33.98	45.5	77.80	46.10	71.92
22.0	37.62	22.29	34.77	46.0	78.66	46.60	72.71
22.5	38.47	22.80	35.56	46.5	79.51	47.11	73.50
23.0	39.33	23.30	36.35	47.0	80.37	47.62	74.29
23.5	40.18	23.81	37.14	47.5	81.22	48.12	75.08
24.0	41.04	24.31	37.93	48.0	82.07	48.63	75.87

55—Continued.

Gay-Lussac degrees Na ² O	German degrees Na ² CO ₃	English degrees Na ² O	Descroizilles degrees H ² SO ₄	Gay-Lussac degrees Na ² O	German degrees Na ² CO ₃	English degrees Na ² O	Descroizilles degrees H ² SO ₄
48.5	82.98	49.14	76.66	63.5	108.57	64.88	100.87
49.0	83.78	49.64	77.45	64.0	109.43	64.84	101.16
49.5	84.64	50.15	78.44	64.5	110.28	65.35	101.95
50.0	85.48	50.66	79.03	65.0	111.14	65.85	102.74
50.5	86.34	51.16	79.82	65.5	111.99	66.36	103.53
51.0	87.19	51.67	80.61	66.0	112.85	66.87	104.32
51.5	88.05	52.18	81.40	66.5	113.70	67.37	105.11
52.0	88.90	52.68	82.19	67.0	114.56	67.88	105.90
52.5	89.76	53.19	82.98	67.5	115.41	68.39	106.69
53.0	90.61	53.70	83.77	68.0	116.27	68.89	107.48
53.5	91.47	54.20	84.56	68.5	117.12	69.40	108.27
54.0	92.32	54.71	85.35	69.0	117.98	69.91	109.06
54.5	93.18	55.22	86.14	69.5	118.83	70.41	109.85
55.0	94.03	55.73	86.93	70.0	119.69	70.92	110.64
55.5	94.89	56.23	87.72	70.5	120.53	71.43	111.43
56.0	95.74	56.74	88.52	71.0	121.39	71.93	112.23
56.5	96.60	57.24	89.31	71.5	122.24	72.44	113.02
57.0	97.45	57.75	90.10	72.0	123.10	72.95	113.81
57.5	98.31	58.26	90.89	72.5	123.95	73.45	114.60
58.0	99.16	58.76	91.68	73.0	124.81	73.96	115.39
58.5	100.02	59.27	92.47	73.5	125.66	74.47	116.18
59.0	100.87	59.77	93.26	74.0	126.52	74.97	116.95
59.5	101.73	60.28	94.05	74.5	127.37	75.48	117.76
60.0	102.58	60.79	94.84	75.0	128.23	75.99	118.55
60.5	103.44	61.30	95.63	75.5	129.08	76.49	119.34
61.0	104.30	61.80	96.42	76.0	129.94	77.00	120.13
61.5	105.15	62.31	97.21	76.5	130.79	77.51	120.92
62.0	106.01	62.82	98.00	77.0	131.65	78.01	121.71
62.5	106.86	63.32	98.79	77.5	132.50	78.52	122.50
63.0	107.72	63.83	99.58				

Gay-Lussac degrees express the percentage by weight of available soda Na²O.

The English degrees (Liverpool degrees) express the same, but the calculation is erroneously founded on the mol. weight 31 instead of the correct mol. weight 32.

The German degrees show the amount of sodium carbonate corresponding to Gay-Lussac degrees, and are used in Germany and Russia.

Descroizilles degrees give the amount of parts of sulfuric acid which are saturated by 100 parts of the analyzed alkaline substance.

56. SPECIFIC GRAVITY OF SOLUTIONS OF LEAD ACETATE
 $[\text{Pb}(\text{C}^2\text{H}^3\text{O}^2)_2]$ 3 Aq. AT 20° C. (F. SALOMON).

Grams in 100 cubic centimeter	Specific gravity.	Grams in 100 cubic centimeter	Specific gravity.	Grams in 100 cubic centimeter.	Specific gravity.
1	1.0062	18	1.1118	35	1.2142
2	1.0124	19	1.1180	36	1.2201
3	1.0186	20	1.1242	37	1.2261
4	1.0248	21	1.1302	38	1.2320
5	1.0311	22	1.1362	39	1.2380
6	1.0373	23	1.1422	40	1.2440
7	1.0435	24	1.1482	41	1.2499
8	1.0497	25	1.1543	42	1.2558
9	1.0559	26	1.1603	43	1.2617
10	1.0622	27	1.1663	44	1.2676
11	1.0684	28	1.1723	45	1.2735
12	1.0746	29	1.1783	46	1.2794
13	1.0808	30	1.1844	47	1.2853
14	1.0870	31	1.1903	48	1.2912
15	1.0932	32	1.1963	49	1.2971
16	1.0994	33	1.2022	50	1.3030
17	1.1056	34	1.2082		

57. SPECIFIC GRAVITY OF SOLUTIONS OF LEAD SUBACETATE,
 $\text{Pb}(\text{C}^2\text{H}^3\text{O}^2)_2 + x \text{ PbO}$ AT 20° C. (F. SALOMON).

Gram PbO in 100 cubic centimeter.	Increase of specific gravity.	Gram PbO in 100 cubic centimeter.	Increase of specific gravity.	Gram PbO in 100 cubic centimeter.	Increase of specific gravity.
1	0.00685	8	0.07080	15	0.13275
2	0.01770	9	0.07965	16	0.14160
3	0.02655	10	0.08850	17	0.15045
4	0.03540	11	0.09735	18	0.15930
5	0.04425	12	0.10620	19	0.16815
6	0.05310	13	0.11505	20	0.17700
7	0.06195	14	0.12390		

These tables show the increase in specific gravity of solutions of Lead Acetate (given in 56) by dissolving given quantities of PbO in 100 cubic centimeter.

58. SPECIFIC GRAVITY OF SOLUTIONS OF TARTAR EMETIC AT
 17.5° C. (G. STREIT).

Per cent. Tartar Emetic.	Specific gravity.	Per cent. Tartar Emetic.	Specific gravity.	Per cent. Tartar Emetic.	Specific gravity.
0.5	1.003	2.5	1.015	4.5	1.031
1.0	1.007	3.0	1.018	5.0	1.035
1.5	1.009	3.5	1.022	5.5	1.038
2.0	1.012	4.0	1.027	6.0	1.041

D.—ALCOHOLS.

59. DENSITIES OF MIXTURES OF ALCOHOL WITH WATER AT 60° F.

Degrees Gay-Lussac=Degrees Tralles, used officially by the U. S. Treasury Department, may be found by dividing with two the percentage by measure of U. S. proof spirit.

Specific gravity of absolute Alcohol at 60° F. —0.79384

Specific gravity of English Proof Spirit at 60° F. —0.91984

Specific gravity of U. S. Proof Spirit at 60° F. —0.93353

Specific gravity at 60° F.	Per cent. of absolute Alcohol.	Per cent. of English Proof Spirit by measure.	Per cent. of U. S. Proof Spirit by measure.	Specific gravity at 60° F.	Per cent. of absolute Alcohol.	Per cent. of English Proof Spirit by measure.	Per cent. of U. S. Proof Spirit by measure.
0.7938	100.00	175.25	200.0	0.872	70.4	134.84	153.9
0.794	99.94	175.18	199.9	0.874	69.21	133.54	152.4
0.796	99.29	174.49	199.1	0.876	68.38	132.23	150.9
0.798	98.66	173.81	198.3	0.878	67.54	130.93	149.4
0.800	98.03	173.14	197.5	0.880	66.70	129.57	147.8
0.802	97.37	172.39	196.7	0.882	65.83	128.19	146.3
0.804	96.70	171.64	195.8	0.884	65.00	126.85	144.7
0.806	96.03	170.88	195.0	0.886	64.13	125.44	143.1
0.808	95.32	170.03	194.0	0.888	63.26	124.03	141.5
0.810	94.62	169.20	193.1	0.890	62.36	122.53	139.8
0.812	93.92	168.38	192.1	0.892	61.50	121.11	138.2
0.814	93.18	167.46	191.0	0.894	60.67	119.74	136.6
0.816	92.44	166.53	190.0	0.896	59.83	118.34	135.0
0.818	92.71	165.62	189.0	0.898	58.95	116.88	133.4
0.820	91.00	164.74	188.0	0.900	58.05	115.33	131.6
0.822	90.29	163.84	186.9	0.902	57.21	113.93	130.0
0.824	89.54	162.88	185.8	0.904	56.33	112.41	128.3
0.826	88.76	161.86	184.7	0.906	55.41	110.84	126.5
0.828	87.96	160.79	183.5	0.908	54.43	109.20	124.6
0.830	87.19	159.77	182.3	0.910	53.57	107.61	122.8
0.832	86.42	158.74	181.1	0.912	52.68	106.07	121.0
0.834	85.65	157.71	180.0	0.914	51.79	104.50	119.2
0.836	84.88	156.66	178.8	0.916	50.96	103.05	117.6
0.838	84.08	155.55	177.5	0.918	50.09	101.51	115.8
0.840	83.31	154.49	176.3	0.91984	49.24	100.00	114.1
0.842	82.54	153.43	175.1	0.920	49.16	99.86	113.9
0.844	81.76	152.34	173.8	0.921	48.73	99.08	113.1
0.846	80.96	151.21	172.5	0.922	48.27	98.26	112.1
0.848	80.13	150.00	171.2	0.923	47.82	97.44	111.3
0.850	79.32	148.84	169.8	0.924	47.36	96.62	110.2
0.852	78.52	147.69	168.5	0.925	46.91	95.79	109.3
0.854	77.71	146.51	167.3	0.926	46.46	94.97	108.4
0.856	76.88	145.28	165.8	0.927	46.00	94.14	107.4
0.858	76.04	144.04	164.4	0.928	45.55	93.31	106.5
0.860	75.14	142.66	162.8	0.929	45.09	92.48	105.5
0.862	74.23	141.26	161.2	0.930	44.64	91.64	104.6
0.864	73.38	139.96	159.7	0.931	44.18	90.81	103.6
0.866	72.52	138.65	158.2	0.932	43.71	89.99	102.4
0.868	71.67	137.33	156.7	0.933	43.24	89.06	101.6
0.870	70.84	136.07	155.3	0.934	42.76	88.18	100.6

59—Continued.

Specific gravity at 60° F.	Per cent. of absolute Alcohol.	Per cent. of English Proof Spirit by measure.	Per cent. of U. S. Proof Spirit by measure.	Specific gravity at 60° F.	Per cent. of absolute Alcohol.	Per cent. of English Proof Spirit by measure.	Per cent. of U. S. Proof Spirit by measure.
0.935	42.29	87.29	99.6	0.9686	22.38	47.87	54.6
0.936	41.80	86.87	98.5	0.9688	22.23	47.55	54.3
0.937	41.30	85.43	97.5	0.9690	22.08	47.23	54.0
0.938	40.80	84.49	96.4	0.9692	21.91	46.92	53.6
0.939	40.30	83.54	95.3	0.9694	21.77	46.59	53.2
0.940	39.80	82.59	94.2	0.9696	21.62	46.27	52.8
0.941	39.30	81.64	93.2	0.9698	21.46	45.95	52.4
0.942	38.78	80.64	92.0	0.9700	21.31	45.63	52.1
0.943	38.22	79.57	90.8	0.9702	21.15	45.31	51.7
0.944	37.67	78.50	89.6	0.9704	21.00	44.99	51.3
0.945	37.11	77.42	88.3	0.9706	20.83	44.63	50.9
0.946	36.56	76.34	87.1	0.9708	20.66	44.29	50.5
0.947	36.00	75.26	85.9	0.9710	20.50	43.94	50.1
0.948	35.50	74.30	84.8	0.9712	20.33	43.60	49.7
0.949	35.00	73.33	83.7	0.9714	20.17	43.25	49.3
0.950	34.52	72.41	82.6	0.9716	20.00	42.90	48.9
0.951	34.05	71.48	81.6	0.9718	19.83	42.55	48.5
0.952	33.47	70.34	80.3	0.9720	19.66	42.20	48.1
0.953	32.87	69.16	78.9	0.9722	19.50	41.85	47.7
0.954	32.25	67.92	77.5	0.9724	19.33	41.51	47.3
0.955	31.62	66.68	76.1	0.9726	19.17	41.16	46.9
0.956	31.00	65.43	74.7	0.9728	19.00	40.81	46.5
0.957	30.44	64.32	73.4	0.9730	18.85	40.48	46.2
0.958	29.87	63.17	72.0	0.9732	18.69	40.16	45.8
0.959	29.29	61.83	70.5	0.9734	18.54	39.83	45.4
0.960	28.56	60.53	69.1	0.9736	18.38	39.51	45.0
0.961	27.93	59.26	67.4	0.9738	18.23	39.19	44.6
0.962	27.21	57.80	65.9	0.9740	18.08	38.87	44.3
0.963	26.53	56.41	64.4	0.9742	17.91	38.53	44.0
0.964	25.86	55.03	62.8	0.9744	17.75	38.18	43.6
0.965	25.14	53.56	61.1	0.9746	17.58	37.83	43.2
0.9652	25.00	53.27	60.8	0.9748	17.42	37.48	42.8
0.9654	24.85	52.95	60.4	0.9750	17.25	37.13	42.4
0.9656	24.69	52.64	60.0	0.9752	17.08	36.78	42.0
0.9658	24.54	52.32	59.7	0.9754	16.91	36.43	41.6
0.9660	24.38	52.00	59.3	0.9756	16.75	36.11	41.2
0.9662	24.23	51.69	59.0	0.9758	16.58	35.77	40.8
0.9664	24.08	51.37	58.6	0.9760	16.42	35.46	40.5
0.9666	23.92	51.05	58.2	0.9762	16.25	35.14	40.1
0.9668	23.77	50.73	57.9	0.9764	16.08	34.82	39.7
0.9670	23.62	50.41	57.5	0.9766	15.91	34.50	39.3
0.9672	23.46	50.10	57.0	0.9768	15.75	34.14	38.9
0.9674	23.31	49.78	56.8	0.9770	15.58	33.78	38.5
0.9676	23.15	49.47	56.4	0.9772	15.42	33.43	38.1
0.9678	23.00	49.15	56.1	0.9774	15.25	33.08	37.7
0.9680	22.85	48.83	55.7	0.9776	15.08	32.73	37.3
0.9682	22.69	48.51	55.3	0.9778	14.91	32.38	36.9
0.9684	22.54	48.19	55.0	0.9780	14.75	31.99	36.5

59—Continued.

Specific gravity at 60° F.	Per cent. of absolute Alcohol.	Per cent. of English Proof Spirit by measure.	Per cent. of U. S. Proof Spirit by measure.	Specific gravity at 60° F.	Per cent. of absolute Alcohol.	Per cent. of English Proof Spirit by measure.	Per cent. of U. S. Proof Spirit by measure.
0.9782	14.58	31.60	36.1	0.9878	7.23	15.77	18.1
0.9784	14.42	31.23	35.7	0.9880	7.09	15.47	17.7
0.9786	14.25	30.84	35.3	0.9882	6.95	15.16	17.3
0.9788	14.08	30.45	34.9	0.9884	6.82	14.88	17.0
0.9790	13.92	30.10	34.5	0.9886	6.69	14.60	16.7
0.9792	13.77	29.77	34.1	0.9888	6.55	14.30	16.3
0.9794	13.62	29.44	33.7	0.9890	6.42	14.02	16.0
0.9796	13.46	29.11	33.3	0.9892	6.29	13.74	15.7
0.9798	13.31	28.79	32.9	0.9894	6.15	13.43	15.3
0.9800	13.15	28.46	32.5	0.9896	6.02	13.15	15.0
0.9802	13.00	28.13	32.1	0.9898	5.88	12.87	14.7
0.9804	12.85	27.80	31.7	0.9900	5.77	12.61	14.4
0.9806	12.69	27.48	31.4	0.9902	5.64	12.33	14.1
0.9808	12.54	27.15	31.0	0.9904	5.51	12.05	13.8
0.9810	12.39	26.82	30.6	0.9906	5.39	11.79	13.5
0.9812	12.23	26.49	30.2	0.9908	5.26	11.51	13.2
0.9814	12.08	26.16	29.8	0.9910	5.13	11.22	12.9
0.9816	11.92	25.83	29.4	0.9912	5.01	10.96	12.6
0.9818	11.77	25.50	29.0	0.9914	4.88	10.68	12.3
0.9820	11.62	25.17	28.6	0.9916	4.76	10.42	12.0
0.9822	11.46	24.84	28.2	0.9918	4.64	10.16	11.7
0.9824	11.31	24.52	27.9	0.9920	4.51	9.88	11.4
0.9826	11.15	24.20	27.5	0.9922	4.39	9.62	11.1
0.9828	11.00	23.87	27.1	0.9924	4.27	9.36	10.8
0.9830	10.85	23.47	26.7	0.9926	4.14	9.07	10.5
0.9832	10.69	23.07	26.3	0.9928	4.02	8.81	10.2
0.9834	10.44	22.67	25.9	0.9930	3.90	8.55	9.9
0.9836	10.26	22.27	25.5	0.9932	3.78	8.29	9.6
0.9838	10.07	21.87	25.1	0.9934	3.67	8.05	9.3
0.9840	9.92	21.55	24.7	0.9936	3.55	7.79	9.0
0.9842	9.78	21.25	24.3	0.9938	3.43	7.53	8.7
0.9844	9.63	20.93	23.9	0.9940	3.32	7.29	8.4
0.9846	9.49	20.63	23.6	0.9942	3.20	7.02	8.1
0.9848	9.34	20.31	23.2	0.9944	3.08	6.76	7.8
0.9850	9.20	20.01	22.8	0.9946	2.97	6.52	7.5
0.9852	9.05	19.69	22.5	0.9948	2.85	6.26	7.2
0.9854	8.91	19.38	22.1	0.9950	2.74	6.02	6.9
0.9856	8.77	19.08	21.8	0.9952	2.62	5.76	6.6
0.9858	8.62	18.76	21.4	0.9954	2.51	5.52	6.3
0.9860	8.48	18.46	21.1	0.9956	2.39	5.25	6.0
0.9862	8.34	18.16	20.8	0.9958	2.28	5.01	5.7
0.9864	8.20	17.86	20.4	0.9960	2.17	4.77	5.4
0.9866	8.06	17.56	20.1	0.9962	2.05	4.51	5.1
0.9868	7.92	17.26	19.8	0.9964	1.94	4.27	4.8
0.9870	7.78	16.95	19.4	0.9966	1.83	4.03	4.5
0.9872	7.64	16.65	19.1	0.9968	1.73	3.81	4.3
0.9874	7.50	16.35	18.7	0.9970	1.61	3.54	4.0
0.9876	7.37	16.07	18.4	0.9972	1.51	3.32	3.8

59—Continued.

Specific gravity at 60° F.	Per cent. of absolute Alcohol.	Per cent. of English Proof Spirit by measure.	Per cent. of U. S. Proof Spirit by measure.	Specific gravity at 60° F.	Per cent. of absolute Alcohol.	Per cent. of English Proof Spirit by measure.	Per cent. of U. S. Proof Spirit by measure.
0.9974	1.40	3.08	3.5	0.9988	0.64	1.41	1.5
0.9976	1.29	2.84	3.2	0.9990	0.53	1.17	1.2
0.9978	1.18	2.60	2.9	0.9992	0.42	0.98	1.0
0.9980	1.07	2.36	2.6	0.9994	0.32	0.71	0.8
0.9982	0.96	2.12	2.3	0.9996	0.21	0.46	0.5
0.9984	0.85	1.87	2.0	0.9998	0.11	0.24	0.3
0.9986	0.74	1.63	1.7	1.0000	0.00	0.00	0.0

60. DENSITY AND STRENGTH OF WOOD ALCOHOL AT 15.5° (U.S.).

Methyllic Alcohol, per cent., by weight.	Specific gravity.	Methyllic Alcohol, per cent., by weight.	Specific gravity.	Methyllic Alcohol, per cent., by weight.	Specific gravity.
100.00	0.8136	77.00	0.8820	58.82	0.9248
98.00	0.8216	75.76	0.8842	57.73	0.9266
96.11	0.8256	74.63	0.8876	56.18	0.9296
94.34	0.8320	73.53	0.8918	53.70	0.9344
92.22	0.8384	72.46	0.8930	51.84	0.9386
90.90	0.8418	71.43	0.8950	50.00	0.9414
89.30	0.8470	70.42	0.8984	47.62	0.9448
87.72	0.8514	69.44	0.9008	46.00	0.9484
86.20	0.8564	68.50	0.9032	43.48	0.9518
84.75	0.8596	67.56	0.9060	41.66	0.9540
83.33	0.8642	66.66	0.9070	40.00	0.9564
82.00	0.8674	65.00	0.9116	38.46	0.9584
80.64	0.8712	63.30	0.9154	37.11	0.9600
79.36	0.8742	61.73	0.9184	35.71	0.9620
78.13	0.8784	60.24	0.9218		

61. SPECIFIC GRAVITY OF SOLUTIONS OF GLYCEROL (GLYCERINE).

Per cent. Water.	Spec. grav. after Champion and Pellet.	Degrees Beaumé after Berthelot.	Per cent. Water.	Spec. grav. after Champion and Pellet.	Degrees Beaumé after Berthelot.	Per cent. Water.	Spec. grav. after Champion and Pellet.	Degrees Beaumé after Berthelot.
0	1.2640	31.2	7.5	1.2440	29.5	14.5	1.2255	27.6
0.5	1.2625	31.0	8.0	1.2427	29.3	15.0	1.2242	27.4
1.0	1.2612	30.9	8.5	1.2412	29.2	15.5	1.2230	27.3
1.5	1.2600	30.8	9.0	1.2400	29.0	16.0	1.2217	27.2
2.0	1.2585	30.7	9.5	1.2390	28.9	16.5	1.2202	27.0
2.5	1.2575	30.6	10.0	1.2375	28.8	17.0	1.2190	26.9
3.0	1.2560	30.4	10.5	1.2362	28.7	17.5	1.2177	26.8
3.5	1.2545	30.3	11.0	1.2350	28.6	18.0	1.2163	26.7
4.0	1.2532	30.2	11.5	1.2335	28.4	18.5	1.2150	26.5
4.5	1.2520	30.1	12.0	1.2322	28.3	19.0	1.2137	26.4
5.0	1.2505	30.0	12.5	1.2307	28.2	19.5	1.2125	26.3
5.5	1.2490	29.9	13.0	1.2295	28.0	20.0	1.2112	26.2
6.0	1.2470	29.8	13.5	1.2280	27.8	20.5	1.2100	26.0
6.5	1.2465	29.7	14.0	1.2270	27.7	21.0	1.2085	25.9
7.0	1.2455	29.6						

62.

CRYSTALLIZATION TABLE.

The following figures express the density in degrees Beaumé, to which salt-solutions must be evaporated in order to produce good crystals, after cooling.

Aluminum sulfate.....	25	Magnesium sulfate.....	40
Ammonium alum.....	20	Magnesium thio-sulfate....	40
Ammonium acetate.....	14	Manganous acetate.....	26
Ammonium arsenate.....	50	Manganous chlorid.....	47
Ammonium benzoate.....	5	Manganic lactate.....	8
Ammonium bichromate.....	28	Manganous sulfate.....	44
Ammonium bromid.....	30	Mercury cyanid.....	20
Ammonium chlorid.....	12	Nickelic acetate.....	30
Ammonium cupro-sulfate.....	35	Nickelous chlorid.....	50
Ammonium sodium-phos- phate.....	20	Nickelic sulfate.....	40
Ammonium nitrate.....	28-30	Oxalic acid.....	12
Ammonium oxalate.....	5	Potash alum.....	20
Ammonium phosphate.....	35	Potassium arseniate.....	36
Ammonium sulfate.....	28	Potassium bi sulfate.....	35
Ammonium sulfo-cyanid..	18	Potassium bromid.....	40
Ammonium tartrate.....	25	Potassium chlorate.....	22
Ammonium thio-sulfate....	37	Potassium chlorid.....	25
Ammonium zinc-chlorid,..	43	Potassium chromate.....	38
Barium chlorate.....	40	Potassium citrate.....	36
Barium chlorid.....	35	Potassium ferro-cyanid....	38
Barium ferriate.....	32	Potassium iodate.....	17
Barium hydroxid.....	12	Potassium sodium-tartrate	36
Barium thio-sulfate.....	24	Potassium nitrate.....	28
Barium nitrate.....	18	Potassium oxalate.....	30
Bismuth nitrate.....	70	Potassium permanganate..	25
Boracic acid.....	6	Potassium sulfate.....	15
Borax.....	24	Potassium sulfo-cyanid....	35
Cadmium bromid.....	65	Potassium tartrate.....	48
Cadmium benzoate.....	2	Sodium acetate.....	22
Calcium benzoate.....	2	Sodium arseniate.....	36
Calcium chlorid.....	40	Sodium bromid.....	55
Calcium lactate.....	8	Sodium carbonate.....	28
Calcium nitrate.....	55	Sodium chlorate.....	43
Calcium thio-sulfate.....	45	Sodium chromate.....	45
Citric acid.....	35	Sodium citrate.....	36
Cobaltous chlorid.....	41	Sodium nitrate.....	40
Cobaltic nitrate.....	50	Sodium phosphate.....	20
Cobaltic sulfate.....	40	Sodium pyrophosphate....	18
Copper acetate.....	5	Sodium sulfate.....	30
Copper chlorid.....	45	Sodium sulfite.....	25
Copper nitrate.....	55	Stannous chlorid, tin cry- stals.....	75
Copper sulfate.....	30	Strontium bromid.....	50
Ferrous sulfate.....	31-32	Strontium chlorate.....	65
Ferrous tartrate.....	40	Strontium chlorid.....	34
Lead acetate.....	42	Strontium nitrate.....	40
Lead nitrate.....	50	Zinc acetate.....	20
Magnesium chlorid.....	35	Zinc nitrate.....	55
Magnesium lactate.....	6	Zinc sulfate.....	45
Magnesium nitrate.....	45		

63. SOLUBILITY OF VARIOUS SUBSTANCES IN 100 PARTS WATER OF DIFFERENT TEMPERATURE.

Temperature °C.	Chlorin.	Bromin.	Hydrochloric Acid HCl	Hydrobromic Acid HBr	Hydroiodic Acid HI	Potassium Bromide	Sodium Bromide	Ammonium Chloride NH ₄ Cl	Saltpetre KNO ₃	Sodium Nitrate NaNO ₃	Barium Nitrate Ba(NO ₃) ₂	Silver Nitrate AgNO ₃	Boric Acid H ₃ BO ₃
0	1.43	...	82.5	...	...	53.48	77.53	8.40	13.32	70.94	5.00	121.95	1.947
5	...	3.6	...	...	...	...	...	...	16.7	...	...	...	...
10	3.0	3.327	77.2	600	425	...	...	32.84	21.1	78.57	7.0	...	2.9
15	...	3.228	74.7	...	...	...	...	...	26.0	...	...	...	...
20	...	3.208	72.1	...	...	64.60	88.49	37.28	31.2	87.97	9.2	227.27 (at 19.5°)	3.992
25	...	3.167	...	...	...	...	...	...	38.4	...	...	...	...
30	...	3.126	67.3	...	...	...	...	41.72	44.5	98.26	11.6	...	6.8
35	1.61	...	...	...	...	...	...	...	54.0	...	...	...	...
40	...	...	63.3	...	...	74.62	104.16	46.16	64.0	109.01	14.2	...	6.991
45	...	...	...	...	...	...	...	...	74.6	...	...	...	...
50	1.19	...	59.6	...	...	...	...	50.60	85.0	190.0	17.07 (at 49.23°)	...	9.8
55	...	...	...	...	...	...	...	...	97.0 (at 54.7°)	...	...	...	...
60	...	...	56.1	...	...	84.74	111.11	55.04	111.0	181.11	20.0	500.0 (at 54°)	11.0
65	...	...	...	...	...	...	...	...	126.0 (at 65.5°)	...	...	...	...
70	.71	...	70	...	...	...	...	59.48	139.0	...	24.0	...	...
75	...	...	...	...	...	...	...	...	155.0	...	...	...	...
80	...	...	...	...	...	93.46	119.36	63.92	170.0	153.72	27.0	690.0	16.815
85	...	...	...	...	...	...	...	...	...	...	...	714.28	...
90	...	...	...	...	...	...	...	68.36	206.0	...	30.0	...	...
95	...	...	...	...	...	...	...	...	226.0	...	...	...	...
100	.15	...	...	...	...	102.04	114.94	72.80	246.0	178.18	35.18 (at 101.65°)	940.0	34.0

Temperature °C.	Boric Acid Anhydrous B ₂ O ₃	Borax Na ₂ B ₄ O ₇ + 10 Aq.	Sodium Carbonate Cryst. Na ₂ CO ₃ + 10 Aq.	Sodium Bicarbonate NaHCO ₃	Ammonium Sulfate (NH ₄) ₂ SO ₄	Potassium Sulfate K ₂ SO ₄	Sodium Sulfate Na ₂ SO ₄	Sodium Sulfate Na ₂ SO ₄ + 10 Aq.	Sodium Sulfate Na ₂ SO ₄ + 7 Aq.
0	1.100	2.88	21.32 (or 23.33?)	6.90	71.00	8.3	.....	12.16	44.84
5	1.100	2.88	.....	7.45	73.65	10.5 (at 13°)	.....	.....	.....
10	1.6	4.65	40.94	8.15	.....	.....	.....	23.04	78.90
15	.....	.....	.....	8.85	76.30	10.9	.....	35.96	105.79
20	2.249	7.88	92.82	9.60	.....	.....	53.76	58.35	140.01
25	3.6	.....	149.13	10.35	.....	.....	51.53	98.48	188.46
30	.....	11.90	273.64	11.10	78.95	12.3	50.37	184.09	.....
35	.....	.....	.....	11.90	.....	.....	49.53 (at 84°)	412.32 (at 84°)	.....
40	8.950	17.90	1142.17 (at 88°)	12.70	81.60	14.0	48.78 (at 40.15°)	.....	.....
45	.....	.....	.....	13.55	.....	.....	47.81	.....	.....
50	6.61?	27.41	.....	14.45	84.35	16.9 (at 49°)	46.88 (at 50.40°)	.....	.....
55	.....	.....	.....	15.40	.....	.....	.....	.....	.....
60	6.1	40.43	.....	16.40	86.90	17.8	45.53 (at 59.79°)	.....	.....
65	.....	.....	.....	.....	.....	19.3 (at 84°)	.....	.....	.....
70	57.85	.....	.....	16.69	89.55	19.8	44.35 (at 70.61°)	.....	.....
75	.....	.....	.....	.....	.....	.....	.....	.....	.....
80	9.800	76.19	.....	.....	92.20	21.8	.....	.....	.....
85	.....	.....	.....	.....	.....	.....	42.95 (at 64.43°)	.....	.....
90	.....	116.06	.....	.....	94.85	23.9	.....	.....	.....
95	.....	.....	.....	.....	.....	.....	42.65 (at 103.17°)	.....	.....
100	21.09	201.43	539.63 (at 104.6°)	.....	97.50	26.31 (at 101.5°)	.....	.....	.....

Temperature °C.	Magnesium Sulfate $MgSO_4$	Calcium Sulfate $CaSO_4 + 2 Aq.$	Ferrous Sulfate $FeSO_4 + 7 Aq.$	Zinc Sulfate $ZnSO_4 + 7 Aq.$	Copper Sulfate $CuSO_4 + 5 Aq.$	Sodium-thio-sulfate $Na_2S_2O_3$	Potassium Chlorate $KClO_3$
0	26.37	0.190	.....	.....	31.6	49.75	3.3
10	31.0	.....	.....	138.21	36.9	.....	.....
15	33.28 (at 17.9°)	0.205 (at 18°)	60.9	.....	.....	.....	6.0
20	36.0	.....	70.0	161.5	42.3	69.44	7.2
25	35.98 (at 24.1°)	0.209 (at 24°)	114.94	.....	.....	.....	8.44 (at 24.4°)
30	41.0	0.212 (at 32°)	.....	190.9	48.8	.....	.....
35	.....	0.214 (at 36°)	.....	.....	.....	.....	12.0
40	46.0	0.2136 (at 41°)	.....	224.0	56.9	104.16	14.44
45	50.0	0.2109 (at 53°)	227.27 (at 46°)	263.8	65.8	.....	.....
50	.....	.....	.....	.....	.....	.....	19.5
55	55.0	0.208	263.15	313.5	77.4	192.8	.....
60	.....	.....	.....	.....	.....	.....	.....
65	60.0	0.202 (at 73°)	.....	369.4	94.0	.....	32.0
70	.....	.....	.....	.....	.....	.....	.....
75	64.0	0.195	.....	442.6	116.0	.....	38.0
80	.....	0.189 (at 83°)	270.27 (at 84°)	.....	.....	.....	.....
85	69.0	.....	370.37	533.0	156.4	.....	.....
90	.....	.....	.....	.....	.....	.....	.....
95	74.0	0.175 (at 99°)	383.83	653.6	208.3	.....	60.0 (at 104.75°)
100	.....	.....	.....	.....	.....	.....	.....

63—Continued.

Temperature.	Succinic Acid $C^2H^2O^4$	Tartaric Acid $C^2H^2O^6$	Barium Hydroxid $Ba(OH)^2 + H^2O$	Barium Chlorid $BaCl^2$	Barium Chlorate $Ba(ClO^3)^2 + H^2O$	Tartar Emetic.	Aluminium- sulfate $Al^2(SO^4)^3 + 18Aq$	Calcium Bromid $CaBr^2$	Cadmium Chlorid $CdCl^2$	Lead Nitrate $Pb(NO^3)^2$
0	8	115	...	31	24.5	..	97	125	...	39
10	5	128	4.7	33	...	5	98	...	...	43
20	...	139	7.4	36	40.0	8	107	143	93	53
30	...	156	...	38	...	12	...	...	...	58
40	15	176	16.5	41	...	16	168	213	100	73
50	22	195	...	44	...	18	...	...	...	86
60	...	217	48.0	46	36.0	22	...	278	108	...
70	...	244	...	49	...	28	348	...	...	106
80	63	273	...	52	...	35	...	...	116	...
90	...	307	...	56	...	...	...	...	...	...
100	121	343	...	59	145.0	...	1140	310	134	139

Temperature.	Potassium Iodid KJ	Potassium Iodate, KJO^3	Sodium Iodid NaJ	Sodium Iodate $NaJO^3$	Tri-sodium-ortho- phosphate Na^3PO^4	Bi-sodium-ortho- phosphate Na^2HPO^4	Sodium Pyro- phosphate $Na^2P^2O^7 + 10aq$	Sodium Pyro- phosphate $Na^2P^2O^7$	Sodium Sulfite Na^2SO^3	Zinc Sulfate $ZnSO^4$
0	128	47	159	2.5	1.5	2.5	5.41	3.16	14	43
10	136	...	...	...	4.1	3.9	6.81	3.95	...	46
20	144	81	178	9.1	11.0	9.3	10.92	6.23	...	53
30	152	...	...	...	20.0	24.1	18.11	9.25	...	58
40	160	...	...	14.4	31.0	33.9	24.97	13.50	49	63
50	168	...	208	...	43.0	32.5	33.25	17.45	...	68
60	176	185	256	21.0	55.0	91.6	44.07	21.83	...	74
70	184	...	...	...	69.0	95.0	52.11	25.62	...	79
80	192	...	300	28.0	81.0	96.6	63.40	30.04	...	85
90	201	...	...	...	95.0	97.8	77.47	35.11	...	90
100	209	320	314	33.0	106.0	99.0	93.11	40.26	...	96

64. BOILING POINTS OF SALT SOLUTIONS (LEGRAND).

The figures under the name of the salt indicate how many parts of salt are dissolved in 100 parts of water. These figures relate to the perfectly anhydrous salts, except those for Ammonium nitrate, the figures of which were determined for the crystallized salt, and Sodium phosphate, which was used dry, but not calcined. Below the double dash the boiling point and the amount of dry salt of the saturated solution are stated.

Boiling point.	Calcium Chlorid.	Potassium Acetate.	Ammonium Nitrate.	Calcium Nitrate.	Potassium Carbonate.	Sodium Acetate.	Sodium Nitrate.	Strontium Chlorid.
101°	10.0	10.5	10.0	15.0	13.0	9.9	9.3	16.7
102	16.5	20.0	20.5	25.3	22.5	17.6	18.7	25.2
103	21.6	28.6	31.3	34.4	31.0	24.1	28.2	32.1
104	25.8	36.4	42.4	42.6	38.8	30.5	37.9	37.9
105	29.4	43.4	53.8	50.4	46.1	36.7	47.7	43.4
106	32.6	49.8	65.4	57.8	53.1	42.9	57.6	48.8
107	35.6	55.8	77.3	64.9	59.6	49.3	67.7	54.0
108	38.5	61.6	89.4	71.8	65.9	55.8	77.9	59.0
109	41.3	67.4	101.9	78.6	71.9	62.4	88.3	63.9
110	44.0	73.3	114.9	85.0	77.6	69.2	98.9	68.9
111	46.8	79.3	128.4	91.9	83.0	76.2	109.5	74.1
112	49.7	85.3	142.4	98.4	88.2	83.4	120.7	79.6
113	52.8	91.4	156.9	104.8	93.2	90.9	131.3	85.3
114	55.6	97.6	172.0	111.2	98.0	98.8	142.4	91.2
115	58.6	103.9	188.0	117.5	102.8	107.1	153.7	97.5
116	61.6	110.3	204.4	123.8	107.5	115.8	165.2	104.0
117	64.6	116.8	221.4	130.0	112.3	125.1	176.8	110.9
118	67.6	123.4	238.8	136.1	117.1	134.9	188.6	
119	70.6	130.1	256.8	142.1	122.0	145.2	200.5	117.8° {
120	73.6	136.9	275.3	148.1	127.0	156.1	212.6	117.5 {
122	79.8	150.8	314.0	160.1	137.0	175.3		
124	86.2	165.1	354.0	172.2	147.1	204.5	121°	
126	88.2	180.1	396.0	184.5	157.3		224.8 {	
128	92.4	196.1	440.2	197.0	167.7	124.4°		
130	104.6	213.0	487.4	209.5	178.1	205.0 {		
132	110.9	230.6	537.3	222.2	188.8			
136	123.5	267.5	645.0	248.1				
140	136.3	308.3	770.5	274.7	135° {			
144	149.4	354.9	915.5	302.6	205.0 {			
148	163.2	407.9	1081.5	333.2				
152	178.1	467.6	1273.0					
156	194.3	534.1	1504.0	151° {				
160	212.1	607.4	1775.0	362.2 {				
164	231.5	687.6	2084.0					
168	252.8	775.0						
172	276.1							
176	301.4	169.0° {						
179.5	325.0	798.2 {						

64—Continued.

Boiling point.	Potassium Nitrate.	Ammonium Chloride.	Potassium Tartrate.	Potassium Chlorate.	Sodium Chloride.	Potassium Chloride.	Sodium Phosphate.	Sodium Carbonate.	Barium Chloride.
101°	12.2	7.8	26.9	14.64	7.7	6.0	21.0	14.4	19.6
102	26.4	13.9	47.2	29.28	13.4	7.1	40.8	26.7	32.5
103	42.2	19.7	65.0	43.92	18.3	24.5	59.4	36.8	44.5
104	59.6	25.2	82.3	58.46	23.1	31.4	76.4	44.7	56.0
105	78.3	30.5	100.1		27.7	37.8	91.5		
106	98.2	35.7	118.5	104.2° { 61.5 }	31.8	44.2	105.0	104.6° { 48.5 }	104.4° { 60.1 }
107	119.0	41.3	137.3		35.8	50.5			
108	140.6	47.3	156.5		39.7	56.9	106.8° { 111.6 }		
109	163.0	53.5	176.1						
110	185.9	59.9	196.2						
111	209.2	66.4	216.8						
112	233.0	73.8	237.9						
113	257.6	80.8	259.5						
114	283.3	88.1	281.6						
115	310.2								
		114.2° { 88.9 }	114.7° { 276.2 }						
	115.9° { 335.1 }								

65. BOILING POINT OF SALT SOLUTIONS.

Substance.	Per cent. in solution.	Boiling point.
Sodium sulfate.....	31.5	100.6
Mercury cyanid.....	35.0	101.1
Copper acetate.....	16.5	101.1
Potassium bitartrate.....	9.5	101.1
Barium nitrate.....	26.5	101.1
Potassium sulfate.....	17.5	101.7
Lead acetate.....	41.5	101.7
Lead nitrate.....	52.5	102.3
Ferrous sulfate.....	64.0	102.3
Copper sulfate.....	45.0	102.3
Potassium ferrocyanid.....	55.0	103.3
Ammonium oxalate.....	29.0	103.3
Sodium carbonate.....	....	104.4
Alum.....	52.0	104.4
Zinc sulfate.....	45.0	104.4
Potassium oxalate.....	40.0	104.4
Borax.....	52.5	105.6
Potassium bisulfate.....	....	105.6
Magnesium sulfate.....	57.5	105.6
Strontium nitrate.....	53.0	106.7
Oxalic acid.....	saturated	112.2
Nickel sulfate.....	65.0	112.6
Potassium hydrate.....	saturated	157.8
Sodium hydrate.....	saturated	215.5

86. TABLE OF FACTORS FOR CALCULATING ANALYTICAL RESULTS.

Sought.	Found.	Mol. Weight of Substance Found.	Factor.
Acetic acid	Carbonic acid anhydrid....	44.0	1.364
Albuminoids	Sulfuric acid anhydrid.....	80.06	1.500
Ammonia.....	Nitrogen.....	14.03	6.250
"	Ammonium chloroplatinate	443.8	0.077
"	Sulfuric acid anhydrid.....	80.06	0.426
"	Ammonium chlorid	53.51	0.318
"	Nitrogen	14.03	1.215
Amylic alcohol	Barium oxid	153.0	1.151
Arsenic	Arsenious anhydrid.....	198.0	0.758
Arsenious anhydrid.....	Arsenic trisulphid.....	246.2	0.804
Barium oxid.....	Carbonic acid anhydrid....	44.0	3.477
"	Barium carbonate.....	195.0	0.777
"	Barium sulfate	233.1	0.657
Calcium oxid.....	Carbonic acid anhydrid....	44.0	1.273
"	Calcium carbonate.....	100.0	0.560
"	Calcium sulfate.....	136.1	0.412
Calcium carbonate.....	Carbonic acid anhydrid....	44.0	2.273
"	Sulfuric acid anhydrid....	80.06	1.249
Calcium sulfate.....	Calcium carbonate.....	100.0	1.360
"	Calcium oxid	56.0	2.430
"	Sulfuric acid anhydrid.....	80.06	1.699
Calcium phosphate.....	Magnesium pyrophosphate.	222.6	1.393
"	Phosphoric acid anhydrid....	142.0	2.183
Carbon	Carbonic acid anhydrid....	44.0	0.273
Carbonic acid.....	Calcium carbonate.....	100.0	0.440
"	Calcium oxid	56.0	0.786
"	Barium carbonate.....	197.0	0.223
Chlorin.....	Silver chlorid.....	143.4	0.247
Citric acid.....	Sulfuric acid anhydrid....	80.06	1.599
Copper	Copper oxid	79.6	0.799
Hydrochloric acid.....	Carbonic acid anhydrid....	44.0	0.829
"	Sulfuric acid anhydrid....	80.06	0.918
"	Silver chlorid.....	143.4	0.254
Humus substance	Carbonic acid anhydrid....	44.0	0.471
"	Carbon.....	12.0	1.727
Iron	Ferrous oxid	72.0	0.773
"	Ferric oxid	128.0	0.700
"	Ferrous-ammonium-sulfate	392.3	0.142
Ferric oxid.....	Ferrous oxid	72.0	1.111
"	Ferrous-ammonium-sulfate	392.3	0.204
"	Ferric phosphate.....	302.0	0.530
Ferrous oxid.....	Ferric oxid	128.0	0.900
"	Ferrous-ammonium-sulfate	392.3	0.184
Lactic acid.....	Sulfuric acid anhydrid....	80.06	2.349
Lead	Lead sulfate.....	303.0	0.683
Lead oxid.....	"	303.0	0.736
Magnesium carbonate..	Carbonic acid anhydrid....	44.0	1.916

Sought.	Found.	Mol. Weight of Substance Found.	Fac- tor.
Magnesium carbonate..	Sulfuric acid anhydrid.....	80.06	1.063
Magnesium oxid.....	Magnesium pyrophosphate.	222.6	0.362
"	Magnesium sulfate.....	120.4	0.335
Manganese peroxid.....	Ferrous-ammonium-sulfate.	392.3	0.111
"	Carbonic acid anhydrid.....	44.0	0.989
Manganic oxid.....	Manganoso-manganic oxid.	229.0	1.035
Manganous oxid.....	"	229.0	0.930
Nitrogen.....	Ammonia.....	17.05	0.823
"	Ammonium chloroplatinate	443.8	0.063
Nitric acid.....	Ammonia.....	17.05	3.169
"	Sulfuric acid anhydrid.....	80.06	1.849
"	Nitrogen.....	14.03	3.851
Phosphoric acid anhydr.	Ferric phosphate.....	302.0	0.470
"	Magnesium pyrophosphate.	222.6	0.638
Potassium carbonate...	Carbonic acid anhydrid.....	44.0	3.141
"	Sulfuric acid anhydrid.....	80.06	1.726
Potassium chlorid.....	Potassium chloroplatinate.	485.9	0.307
Potassium oxid.....	"	485.9	0.1939
"	Potassium chlorid.....	74.56	0.632
"	Carbonic acid anhydrid.....	44.0	2.141
"	Sulfuric acid anhydrid.....	80.06	1.177
"	Potassium sulfate.....	174.28	0.541
Potassium sulfate.....	Potassium chloroplatinate.	485.9	0.359
Potassium bitartrate...	Sulfuric acid anhydrid.....	80.06	2.350
Silver.....	Silver chlorid.....	143.4	0.753
Sodium carbonate.....	Carbonic acid anhydrid.....	44.0	2.411
"	Sulfuric acid anhydrid.....	80.06	1.325
Sodium chlorid.....	Silver chlorid.....	143.4	0.406
Sodium oxid.....	Sodium chlorid.....	58.5	0.531
"	Sodium carbonate.....	106.1	0.585
"	Sodium nitrate.....	85.1	0.363
"	Sodium sulfate.....	142.2	0.437
Strontium oxid.....	Strontium sulfate.....	183.7	0.564
Sulfur.....	Barium sulfate.....	233.1	0.137
Sulfurous acid.....	"	233.1	0.275
Sulfuric acid.....	"	233.1	0.344
Tartaric acid.....	Sulfuric acid.....	80.06	1.874
Tin.....	Stannic acid.....	151.0	0.798
Zinc.....	Zinc oxid.....	81.3	0.603

II. MATHEMATICAL DIVISION.

67. CIRCUMFERENCES AND AREAS OF CIRCLES, SQUARES, CUBES, SQUARE ROOTS AND CUBIC ROOTS.

n	n π	$\frac{\pi}{4}n^2$	n ²	n ³	$\sqrt{n}$	$\sqrt[3]{n}$
1.0	3.142	0.7854	1.00	1.000	1.0000	1.0000
1.5	4.712	1.7672	2.25	3.375	1.2247	1.1447
2.0	6.283	3.1416	4.00	8.000	1.4142	1.2599
2.5	7.854	4.9087	6.25	15.625	1.5811	1.3572
3.0	9.425	7.0686	9.00	27.000	1.7321	1.4422
3.5	10.996	10.6211	12.25	42.875	1.8718	1.5183
4.0	12.566	12.566	16.00	64.000	2.0000	1.5874
4.5	14.137	15.904	20.25	91.125	2.1213	1.6510
5.0	15.708	19.635	25.00	125.000	2.2361	1.7100
5.5	17.279	23.758	30.25	166.875	2.3452	1.7652
6.0	18.850	28.274	36.00	216.000	2.4495	1.8171
6.5	20.420	33.183	42.25	274.625	2.5495	1.8663
7.0	21.991	38.485	49.00	343.000	2.6458	1.9129
7.5	23.562	44.179	56.25	421.875	2.7386	1.9574
8.0	25.133	50.266	64.00	512.000	2.8284	2.0000
8.5	26.704	56.745	72.25	614.125	2.9155	2.0408
9.0	28.274	63.617	81.00	729.000	3.0000	2.0801
9.5	29.845	70.882	90.25	857.375	3.0822	2.1179
10.0	31.416	78.540	100.00	1000.000	3.1623	2.1544
10.5	32.987	86.590	110.25	1157.625	3.2404	2.1897
11.0	34.558	95.033	121.00	1331.000	3.3166	2.2239
11.5	36.128	103.87	132.25	1520.375	3.3912	2.2572
12.0	37.699	113.10	144.00	1728.000	3.4641	2.2894
12.5	39.270	122.72	156.25	1953.125	3.5355	2.3208
13.0	40.841	132.73	169.00	2197.000	3.6056	2.3513
13.5	42.412	143.14	182.25	2460.375	3.6742	2.3811
14.0	43.982	153.94	196.00	2744.000	3.7417	2.4101
14.5	45.553	165.13	210.25	3048.625	3.8079	2.4385
15.0	47.124	176.72	225.00	3375.000	3.8730	2.4662
15.5	48.695	188.69	240.25	3723.875	3.9370	2.4933
16.0	50.265	201.06	256.00	4096.000	4.0000	2.5198
16.5	51.836	213.83	272.25	4492.125	4.0620	2.5458
17.0	53.407	226.98	289.00	4913.000	4.1231	2.5713
17.5	54.978	240.53	306.25	5359.375	4.1833	2.5963
18.0	56.549	254.47	324.00	5832.000	4.2426	2.6207
18.5	58.119	268.80	342.25	6331.625	4.3012	2.6448
19.0	59.690	283.53	361.00	6859.000	4.3589	2.6684
19.5	61.261	298.65	380.25	7414.875	4.4159	2.6916
20.0	62.832	314.16	400.00	8000.000	4.4721	2.7144
20.5	64.403	330.06	420.25	8615.125	4.5277	2.7368
21.0	65.973	346.36	441.00	9261.000	4.5826	2.7589
21.5	67.544	363.05	462.25	9938.375	4.6368	2.7806
22.0	69.115	380.13	484.00	10648.000	4.6904	2.8021
22.5	70.686	397.61	506.25	11390.625	4.7434	2.8231
23.0	72.257	415.48	529.00	12167.000	4.7958	2.8438
23.5	73.827	433.74	552.25	12977.875	4.8477	2.8643
24.0	75.398	452.39	576.00	13824.000	4.8990	2.8845
24.5	76.969	471.44	600.25	14708.125	4.9497	2.9044
25.0	78.540	490.87	625.00	15625.000	5.0000	2.9241

67—Continued.

n	$n\pi$	$\frac{\pi}{n^2}$	n^2	n^3	$\sqrt{n}$	$\sqrt[3]{n}$
25.5	80.111	510.71	650.25	16581.375	5.0497	2.9434
26.0	81.681	530.93	676.00	17576.000	5.0990	2.9634
26.5	83.252	551.55	702.25	18609.625	5.1478	2.9814
27.0	84.823	572.56	729.00	19683.000	5.1962	3.0000
27.5	86.394	598.96	756.25	20796.875	5.2440	3.0184
28.0	87.965	615.75	784.00	21952.000	5.2915	3.0366
28.5	89.535	637.94	812.25	23149.125	5.3385	3.0546
29.0	91.106	660.52	841.00	24389.000	5.3852	3.0723
29.5	92.677	683.49	870.25	25672.375	5.4313	3.0899
30.0	94.248	706.86	900.00	27000.000	5.4772	3.1072
30.5	95.819	730.62	930.25	28372.625	5.5226	3.1244
31.0	97.389	754.77	961.00	29791.000	5.5678	3.1414
31.5	98.960	779.31	992.25	31255.875	5.6124	3.1582
32.0	100.53	804.25	1024.00	32768.000	5.6569	3.1748
32.5	102.10	829.58	1056.25	34328.125	5.7006	3.1918
33.0	103.67	855.30	1089.00	35937.000	5.7446	3.2075
33.5	105.24	881.41	1122.25	37595.375	5.7879	3.2237
34.0	106.81	907.92	1156.00	39304.000	5.8310	3.2396
34.5	108.38	934.82	1190.25	41063.625	5.8736	3.2554
35.0	109.96	962.11	1225.00	42875.000	5.9161	3.2710
35.5	111.53	989.80	1260.25	44738.875	5.9581	3.2866
36.0	113.10	1017.88	1296.00	46656.000	6.0000	3.3019
36.5	114.67	1046.35	1332.25	48627.125	6.0415	3.3171
37.0	116.24	1075.21	1369.00	50653.000	6.0827	3.3322
37.5	117.81	1104.47	1406.25	52734.375	6.1237	3.3472
38.0	119.38	1134.11	1444.00	54872.000	6.1644	3.3620
38.5	120.95	1164.16	1482.25	57066.625	6.2048	3.3767
39.0	122.52	1194.59	1521.00	59319.000	6.2450	3.3912
39.5	124.09	1225.42	1560.25	61629.875	6.2849	3.4056
40.0	125.66	1256.64	1600.00	64000.000	6.3245	3.4200
40.5	127.23	1288.25	1640.25	66430.125	6.3639	3.4341
41.0	128.81	1320.25	1681.00	68921.000	6.4031	3.4482
41.5	130.38	1352.65	1722.25	71473.375	6.4421	3.4622
42.0	131.95	1385.44	1764.00	74088.000	6.4807	3.4760
42.5	133.52	1418.63	1806.25	76765.625	6.5192	3.4896
43.0	135.09	1452.20	1849.00	79507.000	6.5574	3.5034
43.5	136.66	1486.17	1892.25	82312.875	6.5954	3.5169
44.0	138.23	1520.53	1936.00	85184.000	6.6333	3.5303
44.5	139.80	1555.28	1980.25	88121.125	6.6708	3.5437
45.0	141.37	1590.43	2025.00	91125.000	6.7082	3.5569
45.5	142.94	1625.97	2070.25	94196.375	6.7454	3.5700
46.0	144.51	1661.90	2116.00	97336.000	6.7823	3.5830
46.5	146.08	1698.23	2162.25	100544.625	6.8191	3.5960
47.0	147.65	1734.94	2209.00	103823.000	6.8556	3.6088
47.5	149.22	1772.05	2256.25	107171.875	6.8920	3.6216
48.0	150.80	1809.56	2304.00	110592.000	6.9282	3.6342
48.5	152.37	1847.45	2352.25	114084.125	6.9642	3.6468
49.0	153.94	1885.74	2401.00	117649.000	7.0000	3.6593
49.5	155.51	1924.42	2450.25	121287.375	7.0356	3.6717
50.0	157.08	1963.50	2500.00	125000.000	7.0711	3.6840
51.0	160.22	2042.82	2601.00	132651.000	7.1414	3.7064
52.0	163.36	2123.72	2704.00	140608.000	7.2111	3.7285

67—Continued.

n	$n\pi$	$n^2 \frac{\pi}{4}$	n^2	n^3	$\sqrt{n}$	$^2\sqrt{n}$
53.0	166.50	2206.19	2809.00	148877.000	7.2801	3.7563
54.0	169.64	2290.22	2916.00	157464.000	7.3485	3.7798
55.0	172.78	2375.83	3025.00	166875.000	7.4162	3.8080
56.0	175.98	2463.01	3136.00	175616.000	7.4833	3.8259
57.0	179.07	2551.76	3249.00	185198.000	7.5498	3.8485
58.0	182.21	2642.08	3364.00	195112.000	7.6158	3.8709
59.0	185.35	2733.97	3481.00	205379.000	7.6811	3.8930
60.0	188.49	2827.44	3600.00	216000.000	7.7460	3.9149
61.0	191.63	2922.47	3721.00	226981.000	7.8102	3.9365
62.0	194.77	3019.07	3844.00	238328.000	7.8740	3.9579
63.0	197.92	3117.25	3969.00	250047.000	7.9373	3.9791
64.0	201.06	3216.99	4096.00	262144.000	8.0000	4.0000
65.0	204.20	3318.31	4225.00	274625.000	8.0623	4.0207
66.0	207.34	3421.20	4356.00	287496.000	8.1240	4.0412
67.0	210.48	3525.66	4489.00	300768.000	8.1854	4.0615
68.0	213.63	3631.69	4624.00	314432.000	8.2462	4.0817
69.0	216.77	3739.29	4761.00	328509.000	8.3066	4.1016
70.0	219.91	3848.46	4900.00	343000.000	8.3666	4.1213
71.0	223.05	3959.20	5041.00	357911.000	8.4261	4.1408
72.0	226.19	4071.51	5184.00	373248.000	8.4853	4.1602
73.0	229.33	4185.39	5329.00	389017.000	8.5440	4.1798
74.0	232.47	4300.85	5476.00	405224.000	8.6023	4.1988
75.0	235.62	4417.87	5625.00	421875.000	8.6603	4.2172
76.0	238.76	4536.47	5776.00	438976.000	8.7178	4.2358
77.0	241.90	4656.63	5929.00	456533.000	8.7750	4.2543
78.0	245.04	4778.37	6084.00	474552.000	8.8318	4.2727
79.0	248.18	4901.68	6241.00	493039.000	8.8882	4.2908
80.0	251.32	5026.56	6400.00	512000.000	8.9443	4.3089
81.0	254.47	5153.01	6561.00	531441.000	9.0000	4.3267
82.0	257.61	5281.03	6724.00	551368.000	9.0554	4.3445
83.0	260.75	5410.62	6889.00	571787.000	9.1104	4.3621
84.0	263.89	5541.78	7056.00	592704.000	9.1652	4.3795
85.0	267.03	5674.50	7225.00	614125.000	9.2195	4.3968
86.0	270.17	5808.81	7396.00	636056.000	9.2736	4.4140
87.0	273.32	5944.69	7569.00	658503.000	9.3274	4.4310
88.0	276.46	6082.13	7744.00	681472.000	9.3808	4.4480
89.0	279.60	6221.13	7921.00	704969.000	9.4340	4.4647
90.0	282.74	6361.74	8100.00	729000.000	9.4868	4.4814
91.0	285.88	6503.99	8281.00	753571.000	9.5394	4.4979
92.0	289.02	6647.82	8464.00	778688.000	9.5917	4.5144
93.0	292.17	6793.22	8649.00	804357.000	9.6437	4.5307
94.0	295.31	6940.18	8836.00	830584.000	9.6954	4.5468
95.0	298.45	7088.73	9025.00	857375.000	9.7468	4.5629
96.0	301.59	7238.84	9216.00	884736.000	9.7980	4.5789
97.0	304.73	7390.53	9409.00	912673.000	9.8489	4.5947
98.0	307.87	7543.89	9604.00	941192.000	9.8995	4.6104
99.0	311.02	7698.93	9801.00	970299.000	9.9499	4.6261
100.0	314.16	7854.00	10000.00	1000000.000	10.0000	4.6416

In connection with these tables the following formulae may be used as approximately correct:

$$\sqrt{a^2 \pm b} = a \pm \frac{b}{2a} \text{ and } \sqrt[3]{a^3 \pm b} = a \pm \frac{b}{3a^2}$$

Functions of π often applied:

$$\begin{array}{l} \pi = 3.14159 \quad \left| \begin{array}{l} \pi^2 = 9.8696 \\ \sqrt{\pi} = 1.77245 \end{array} \right| \quad \left| \begin{array}{l} \pi^3 = 31.00628 \\ \sqrt[3]{\pi} = 1.46459 \end{array} \right| \quad \left| \begin{array}{l} \frac{1}{\pi} = 0.31831 \\ \sqrt{\frac{1}{\pi}} = 0.564189 \end{array} \right| \end{array}$$

68. FORMULAE FOR CALCULATING AREAS OF SURFACES AND CAPACITIES OF GEOMETRICAL BODIES.

I. CIRCLE.

Radius = r . Area $S = r^2 \pi$.

Area of a sector of the arc of α degrees.

$$S = \frac{\alpha}{360} r^2 \pi.$$

Area of a segment of the arc of α degrees.

$$S = \left(\frac{\alpha}{180} \pi - \sin \alpha \right) \frac{r^2}{2}.$$

II. ELLIPSE.

Semi-axes = a and b .

$$S = \pi a b.$$

III. PARABOLA.

Area of a segment given by chord c and height of the arc h .

$$S = \frac{1}{3} c h.$$

IV. CYLINDER AND PRISM.

Capacity $C = S \text{ basis} \times h$.

Surface of a cylinder left by an ungula.

$$S = \pi r (h_1 + h_2).$$

Capacity of a cylinder left by an ungula.

$$C = \pi r^2 \left(\frac{h_1 + h_2}{2} \right).$$

V. CONE AND PYRAMID.

Capacity = $C = \frac{1}{3} S \text{ basis} \times h$.

Capacity of a frustrum of a cone.

$$C = \frac{h}{3} (S \text{ basis} + \sqrt{S \text{ basis } S \text{ top}} + S \text{ top})$$

h = distance between $S \text{ basis}$ and $S \text{ top}$.

VI. SPHERE.

(S) Surface = $4 \pi r^2$.(S) Surface of a segment of a sphere = $2 \pi r h$.(C) Capacity = $\frac{4}{3} \pi r^3$.

$$\text{Radius} = 0.62085 \sqrt[3]{U}$$

69. COMPARISON OF THERMOMETRICAL SCALES.

GENERAL FORMULÆ.

$$t^{\circ} \text{C.} = \frac{5}{9} t^{\circ} \text{R.} = \frac{5}{9} (t + 32^{\circ} \text{F.})$$

$$t^{\circ} \text{R.} = \frac{9}{5} t^{\circ} \text{C.} = \frac{9}{5} (t + 32^{\circ} \text{F.})$$

$$t^{\circ} \text{F.} = \frac{9}{5} (-32^{\circ} \text{C.}) = \frac{9}{5} (t - 32^{\circ}) \text{R.}$$

Fahrenheit't.	Celsius.	Réaumur.	Fahrenheit't.	Celsius.	Réaumur.
+212	+100.0	+80.0	+174	+78.89	+63.11
211	99.44	79.56	173	78.33	62.67
210	98.89	79.11	172	77.78	62.22
209	98.33	78.67	171	77.22	61.78
208	97.78	78.22	170	76.67	61.33
207	97.22	77.78	169	76.11	60.89
206	96.67	77.33	168	75.56	60.44
205	96.11	76.89	167	75.0	60.0
204	95.56	76.44	166	74.44	59.56
203	95.0	76.0	165	73.89	59.11
202	94.44	75.56	164	73.33	58.67
201	93.89	75.11	163	72.78	58.22
200	93.33	74.67	162	72.22	57.78
199	92.78	74.22	161	71.67	57.33
198	92.22	73.78	160	71.11	56.89
197	91.67	73.33	159	70.56	56.44
196	91.11	72.89	158	70.0	56.0
195	90.56	72.44	157	69.44	55.56
194	90.0	72.0	156	68.89	55.11
193	89.44	71.56	155	68.33	54.67
192	88.89	71.11	154	67.78	54.22
191	88.33	70.67	153	67.22	53.78
190	87.78	70.22	152	66.67	53.33
189	87.22	69.78	151	66.11	52.89
188	86.67	69.33	150	65.56	52.44
187	86.11	68.89	149	65.0	52.0
186	85.56	68.44	148	64.44	51.56
185	85.0	68.0	147	63.89	51.11
184	84.44	67.56	146	63.33	50.67
183	83.89	67.11	145	62.78	50.22
182	83.33	66.67	144	62.22	49.78
181	82.78	66.22	143	61.67	49.33
180	82.22	65.78	142	61.11	48.89
179	81.67	65.33	141	60.56	48.44
178	81.11	64.89	140	60.0	48.0
177	80.56	64.44	139	59.44	47.56
176	80.0	64.0	138	58.89	47.11
175	79.44	63.56	137	58.33	46.67

69—Continued.

Fahrenheit.	Celsius.	Réaumur.	Fahrenheit.	Celsius.	Réaumur.
+136	+57.78	+46.22	+83	+28.33	+22.67
135	57.22	45.78	82	27.78	22.22
134	56.67	45.33	81	27.22	21.78
133	56.11	44.89	80	26.67	21.33
132	55.55	44.44	79	26.11	20.89
131	55.0	44.0	78	25.55	20.44
130	54.44	43.56	77	25.0	20.0
129	53.89	43.11	76	24.44	19.56
128	53.33	42.67	75	23.89	19.11
127	52.78	42.22	74	23.33	18.67
126	52.22	41.78	73	22.78	18.22
125	51.67	41.33	72	22.22	17.78
124	51.11	40.89	71	21.67	17.33
123	50.55	40.44	70	21.11	16.89
122	50.0	40.0	69	20.55	16.44
121	49.44	39.56	68	20.0	16.0
120	48.89	39.11	67	19.44	15.56
119	48.33	38.67	66	18.89	15.11
118	47.78	38.22	65	18.33	14.67
117	47.22	37.78	64	17.78	14.22
116	46.67	37.33	63	17.22	13.78
115	46.11	36.89	62	16.67	13.33
114	45.55	36.44	61	16.11	12.89
113	45.0	36.0	60	15.55	12.44
112	44.44	35.56	59	15.0	12.0
111	43.89	35.11	58	14.44	11.56
110	43.33	34.67	57	13.89	11.11
109	42.78	34.22	56	13.33	10.67
108	42.22	33.78	55	12.78	10.22
107	41.67	33.33	54	12.22	9.78
106	41.11	32.89	53	11.67	9.33
105	40.55	32.44	52	11.11	8.89
104	40.0	32.0	51	10.55	8.44
103	39.44	31.56	50	10.0	8.0
102	38.89	31.11	49	9.44	7.56
101	38.33	30.67	48	8.89	7.11
100	37.78	30.22	47	8.33	6.67
99	37.22	29.78	46	7.78	6.22
98	36.67	29.33	45	7.22	5.78
97	36.11	28.89	44	6.67	5.33
96	35.55	28.44	43	6.11	4.89
95	35.0	28.0	42	5.55	4.44
94	34.44	27.56	41	5.0	4.0
93	33.89	27.11	40	4.44	3.56
92	33.33	26.67	39	3.89	3.11
91	32.78	26.22	38	3.33	2.67
90	32.22	25.78	37	2.78	2.22
89	31.67	25.33	36	2.22	1.78
88	31.11	24.89	35	1.67	1.33
87	30.55	24.44	34	1.11	0.89
86	30.0	24.0	33	0.55	0.44
85	29.44	23.56	32	0.0	0.0
84	28.89	23.11	31	-0.55	-0.44

69—Continued.

Fahrenheit't.	Celsius.	Réaumur.	Fahrenheit't.	Celsius.	Réaumur.
+30	-1.11	-0.89	-6	-21.11	-16.89
29	1.67	1.33	7	21.67	17.33
28	2.22	1.78	8	22.22	17.78
27	2.78	2.22	9	22.78	18.22
26	3.33	2.67	10	23.33	18.67
25	3.89	3.11	11	23.89	19.11
24	4.44	3.56	12	24.44	19.56
23	5.00	4.00	13	25.00	20.00
22	5.55	4.44	14	25.55	20.44
21	6.11	4.89	15	26.11	20.89
20	6.67	5.33	16	26.67	21.33
19	7.22	5.78	17	27.22	21.78
18	7.78	6.22	18	27.78	22.22
17	8.33	6.67	19	28.33	22.67
16	8.89	7.11	20	28.89	23.11
15	9.44	7.56	21	29.44	23.56
14	10.00	8.00	22	30.00	24.00
13	10.55	8.44	23	30.55	24.44
12	11.11	8.89	24	31.11	24.89
11	11.67	9.33	25	31.67	25.33
10	12.22	9.78	26	32.22	25.78
9	12.78	10.22	27	32.78	26.22
8	13.33	10.67	28	33.33	26.67
7	13.89	11.11	29	33.89	27.11
6	14.44	11.56	30	34.44	27.56
5	15.00	12.00	31	35.00	28.00
4	15.55	12.44	32	35.55	28.44
3	16.11	12.89	33	36.11	28.89
2	16.67	13.33	34	36.67	29.33
1	17.22	13.78	35	37.22	29.78
0	17.78	14.22	36	37.78	30.22
-1	18.33	14.67	37	38.33	30.67
2	18.89	15.11	38	38.89	31.11
3	19.44	15.56	39	39.44	31.56
4	20.00	16.00	40	40.00	32.00
5	20.55	16.44			

70.

COMPARISON OF BAROMETRICAL SCALES.

BAROMETRIC PRESSURES IN ENGLISH INCHES COMPARED WITH
PRESSURES IN MILLIMETERS.

English Inches.	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
29.1	739.13	739.38	739.63	739.89	740.14	740.40	740.65	740.90	741.16	741.41
29.2	741.67	741.92	742.17	742.43	742.68	742.94	743.19	743.44	743.70	743.95
29.3	744.21	744.46	744.71	744.97	745.22	745.48	745.73	745.98	746.24	746.49
29.4	746.75	747.00	747.25	747.51	747.76	748.02	748.27	748.52	748.78	749.03
29.5	749.29	749.54	749.79	750.05	750.30	750.56	750.81	751.06	751.32	751.57

70—Continued.

English Inches.	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
29.6	751.83	752.08	752.33	752.59	752.84	753.10	753.35	753.60	753.86	754.11
29.7	754.37	754.62	754.87	755.13	755.38	755.64	755.89	756.14	756.40	756.65
29.8	756.91	757.16	757.41	757.67	757.92	758.18	758.43	758.68	758.94	759.19
29.9	759.45	759.70	759.95	760.21	760.46	760.72	760.97	761.22	761.48	761.73
30.0	761.99	762.24	762.49	762.75	763.00	763.26	763.51	763.76	764.02	764.27
30.1	764.53	764.78	765.03	765.29	765.54	765.80	766.05	766.30	766.56	766.81
30.2	767.07	767.32	767.57	767.83	768.08	768.34	768.59	768.84	769.10	769.35
30.3	769.61	769.86	770.11	770.37	770.62	770.88	771.13	771.38	771.64	771.89
30.4	772.15	772.40	772.65	772.91	773.16	773.42	773.67	773.92	774.18	774.43
30.5	774.69	774.94	775.19	775.45	775.70	775.96	776.21	776.46	776.72	776.97
30.6	777.23	777.48	777.73	777.99	778.24	778.50	778.75	779.00	779.26	779.51
30.7	779.77	780.02	780.27	780.53	780.78	781.04	781.29	781.54	781.80	782.05
30.8	782.31	782.56	782.81	783.07	783.32	783.58	783.83	784.08	784.34	784.59

BAROMETRIC PRESSURES EXPRESSED IN PARISIAN LINES
COMPARED WITH MILLIMETERS.

Parisian lines.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
326	735.40	735.63	735.85	736.08	736.30	736.53	736.75	736.98	737.20	737.43
327	737.66	737.88	738.11	738.33	738.56	738.78	739.01	739.24	739.46	739.69
328	739.91	740.14	740.36	740.59	740.81	741.04	741.27	741.49	741.72	741.94
329	742.17	742.39	742.62	742.84	743.07	743.30	743.52	743.75	743.97	744.20
330	744.42	744.65	744.87	745.10	745.33	745.55	745.78	746.00	746.23	746.55
331	746.68	746.90	747.13	747.36	747.58	747.81	748.03	748.26	748.48	748.71
332	748.94	749.16	749.39	749.61	749.84	750.06	750.29	750.51	750.74	750.97
333	751.19	751.42	751.64	751.87	752.09	752.32	752.54	752.77	753.00	753.23
334	753.45	753.67	753.90	754.12	754.35	754.57	754.80	755.03	755.25	755.48
335	755.70	755.93	756.15	756.38	756.61	756.83	757.06	757.28	757.51	757.73
336	757.96	758.18	758.41	758.64	758.86	759.09	759.31	759.54	759.76	759.99
337	760.21	760.44	760.67	760.89	761.12	761.34	761.57	761.79	762.02	762.24
338	762.47	762.70	762.92	763.15	763.37	763.60	763.82	764.05	764.27	764.70
339	764.78	764.96	765.18	765.40	765.63	765.85	766.08	766.31	766.53	766.76
340	766.98	767.21	767.43	767.66	767.88	768.11	768.34	768.56	768.79	769.01
341	769.24	769.46	769.69	769.91	770.14	770.37	770.59	770.82	771.04	771.27
342	771.49	771.71	771.94	772.17	772.40	772.62	772.85	773.07	773.30	773.52
343	773.75	773.97	774.20	774.43	774.65	774.88	775.10	775.33	775.55	775.78
344	776.01	776.23	776.46	776.68	776.91	777.13	777.36	777.58	777.81	778.04
345	778.26	778.49	778.71	778.94	779.16	779.39	779.61	779.84	780.07	780.29

**71. STEAM PRESSURES EXPRESSED IN POUNDS PER SQUARE INCH,
ATMOSPHERES AND KILOGRAMS PER SQUARE CENTIMETER
FOR DIFFERENT TEMPERATURES.**

Pounds per square inch.	Atmos- pheres.	Kilogr. per sq. centi- meter.	Temp. of steam ° C.	Pounds per square inch.	Atmos- pheres.	Kilogr. per sq. centi- meter.	Temp. of steam ° C.
1	0.07	0.0703	....	48	3.26	3.3749	....
2	0.14	0.1406	....	49	3.33	3.4432	....
3	0.21	0.2109	60.0	50	3.40	3.5155	....
4	0.28	0.2812	....	51	3.47	3.5858	140.6
5	0.34	0.3516	....	52	3.54	3.6561	....
6	0.41	0.4219	....	53	3.60	3.7264	....
7	0.48	0.4922	....	54	3.67	3.7967	....
8	0.54	0.5625	....	55	3.74	3.8670	....
9	0.61	0.6328	86.0	56	3.81	3.9373	....
10	0.68	0.7031	....	57	3.88	4.0076	....
11	0.75	0.7734	....	58	3.94	4.0780	145.4
12	0.81	0.8437	....	59	4.01	4.1483	....
13	0.88	0.9140	....	60	4.08	4.2186	....
14	0.95	0.9843	....	61	4.15	4.2889	....
15	1.02	1.0546	100.0	62	4.22	4.3592	....
16	1.09	1.1250	....	63	4.28	4.4295	....
17	1.16	1.1953	....	64	4.35	4.4998	....
18	1.23	1.2656	....	65	4.42	4.5701	....
19	1.30	1.3359	....	66	4.49	4.6404	149.1
20	1.36	1.4062	....	67	4.56	4.7107	....
21	1.43	1.4765	....	68	4.62	4.7810	....
22	1.50	1.5468	112.2	69	4.69	4.8514	....
23	1.56	1.6171	....	70	4.76	4.9217	....
24	1.63	1.6874	....	71	4.83	4.9920	....
25	1.70	1.7577	....	72	4.90	5.0623	....
26	1.77	1.8280	....	73	4.96	5.1326	....
27	1.84	1.8984	....	74	5.03	5.2029	153.1
28	1.90	1.9687	....	75	5.10	5.2732	....
29	1.97	2.0390	....	76	5.17	5.3435	....
30	2.04	2.1093	121.4	77	5.24	5.4138	....
31	2.11	2.1796	....	78	5.30	5.4841	....
32	2.18	2.2499	....	79	5.37	5.5545	....
33	2.24	2.3202	....	80	5.44	5.6248	....
34	2.31	2.3905	....	81	5.51	5.6951	156.8
35	2.38	2.4608	....	82	5.57	5.7654	....
36	2.45	2.5311	....	83	5.64	5.8357	....
37	2.52	2.6015	128.8	84	5.71	5.9060	....
38	2.58	2.6718	....	85	5.78	5.9763	....
39	2.65	2.7421	....	86	5.85	6.0466	....
40	2.72	2.8124	....	87	5.92	6.1169	....
41	2.79	2.8827	....	88	5.98	6.1872	160.2
42	2.86	2.9530	....	89	6.05	6.2575	....
43	2.92	3.0233	....	90	6.12	6.3279	....
44	2.99	3.0936	135.1	91	6.19	6.3982	....
45	3.06	3.1639	....	92	6.25	6.4685	....
46	3.13	3.2342	....	93	6.32	6.5388	....
47	3.20	3.3045	....	94	6.39	6.6091	....

71—Continued.

Pounds per square inch.	Atmos- pheres.	Kilogr. per sq. centi- meter.	Temp. of steam ° C.	Pounds per square inch.	Atmos- pheres.	Kilogr. per sq. centi- meter.	Temp. of steam ° C.
95	6.46	6.6794	....	110	7.49	7.784	169.0
96	6.53	6.7497	163.5	120	8.17	8.437	....
97	6.60	6.8200	....	130	8.85	9.140	....
98	6.66	6.8903	....	140	9.53	9.843	180.0
99	6.73	6.9606	....	150	10.21	10.546	....
100	6.80	7.0310	....	160	10.89	11.250	....
101	6.87	7.1013	....	170	11.57	11.953	190.0
102	6.94	7.1716	....	180	12.25	12.656	....
103	7.00	7.2419	166.5	190	12.93	13.359	....
104	7.07	7.3122	....	200	13.61	14.062	....
105	7.14	7.3825	....	210	14.29	14.765	....
106	7.21	7.4528	....	220	14.97	15.468	200.0
107	7.28	7.5231	....	230	15.65	16.171	....
108	7.35	7.5934	....	240	16.33	16.874	....
109	7.42	7.6637	....	250	17.01	17.577	207.0

72. I. UNITED STATES SYSTEM OF MEASURES AND WEIGHTS COM-
PARED WITH THE METRIC SYSTEM.

1. Linear Measures.

1 mile = 8 frigs = 80 chains = 320 perches = 5280 ft = 1609.344 m

1 frig = 10 chains = 40 perches = 660 ft = 201.168 m

1 chain = 4 perches = 66 ft = 20.1168 m

1 perch = 16½ ft = 5.0292 m

1 chain = 100 links

1 link = 7.92 inches = 0.201168 m

1 yard = 3 feet = 36 inches = 0.9144 m

1 foot = 12 inches = 0.3048 m

1 inch = 0.0254 m

2. Surface Measures.

1 sq. mile = 640 acres

1 acre = 10 sq. chains = 160 sq. perches = 43560 sq. ft = 40.4694 ar.

3. Measures of Capacity.

A.—DRY MEASURE.

1 bushel = 2150.42 cub. inches

1 bushel = the volume of 77.627 lbs. of distilled water at 4° C

Legal: 1 liter = 0.908 quart

1 bushel = 4 pecks = 8 gallons = 32 qts = 35.24229 l

1 peck = 2 gallons = 8 qts = 8.81057 l

1 gallon = 4 qt = 4.40528 l

1 qt = 1.10139 l

1 cub. foot = 7.48 gallon = 29.915 l = 62.42 lbs of water at 60°F

B.—LIQUID MEASURE.

1 gallon = 231 cub. inches
 1 gallon = the volume of 8.3333322 lbs. = 58373 troy grains of distilled water at 4° C
 Legal: 1 liter = 1.0567 qt = 0.26417 gallon

1 gallon = 4 quarts = 8 pints = 32 gills = 3.78544 l
 1 quart = 2 pints = 8 gills = 0.94636 l
 1 pint = 4 gills = 0.47318 l
 1 gill = 0.118295 l

4. Weights.

1 grain troy = 0.0648004 gram
 1 lb. troy = 0.822857 lb. avoirdupois
 1 lb. avoirdupois = 7000 grains troy = 1.215279 lbs. troy

A.—AVOIRDUPOIS WEIGHTS.

1 ton = 20 cwt = 2240 lbs = 1016.070 Kg
 1 cwt = 112 lbs = 50.8035 Kg

1 lb = 16 oz = 256 drams = 768 scruples = 7680 grains = 453.603 grams
 1 oz = 16 drams = 48 scruples = 480 grains = 28.350 grams
 1 dram = 3 scruples = 30 grains = 1.772 grams
 1 scruple = 10 grains = 0.5906 gram

B.—TROY WEIGHT FOR DRUGS.

1 lb = 12 oz = 96 drams = 288 scruples = 5760 grains = 373.2503 grams
 1 oz = 8 drams = 24 scruples = 480 grains = 31.1042 grams
 1 dram = 3 scruples = 60 grains = 3.888025 grams
 1 scruple = 20 grains = 1.296006 grams
 1 grain = 0.0648004 gram

C. TROY WEIGHT FOR JEWELS AND PRECIOUS METALS.

1 lb = 12 oz = 24 carats = 240 pwts = 5760 grains = 373.2503 grams
 1 oz = 2 carats = 20 pwts = 480 grains = 31.1042 grams
 1 carat = 10 pwts = 240 grains = 15.5521 grams
 1 pennyweight = 24 grains = 1.55521 grams
 1 grain = 0.0648004 gram

II. THE METRIC SYSTEM OF WEIGHTS AND MEASURES COMPARED WITH THE UNITED STATES SYSTEM.**1. Linear Measures.**

$1 \text{ m} = \frac{1}{10^7}$ part of an earth meridian quadrant.

1 Meter (m) = 10 Decimeters (dm) = 100 Centimeters (cm) = 1,000 Millimeters (mm) = 0.1 Dekameter (Dm) = 0.01 Hektometer (Hm) = 0.001 Kilometer (Km) = 0.0001 Myriameter (Mm)

1 Mm = 10 Km = 100 Hm = 1000 Dm = 10000 m = 6.214 miles
 1 Km = 10 Hm = 100 Dm = 1000 m = 3.280.87 feet
 1 Hm = 10 Dm = 100 m = 328.09 feet
 1 Dm = 10 m = 32.81 feet

1 m = 10 dm = 100 cm = 1000 mm = 39.3704 inches
 1 dm = 10 cm = 100 mm = 3.9370 inches
 1 cm = 10 mm = 0.3937 inches

2. Surface Measures.

1 Ar (a) = 1 square dekameter (sq. Dm) = 100 square meters (sq. m)
= 0.01 hektar (ha)

1 Ar = 100 Dm = 10000 m

10 Km = 100 HA = 10,000 A = 1,000,000 m = 247.10 acres

1 HA = 100 A = 10,000 m = 2.471 acres

1 A = 100 m = 1076.37 sq. feet

3. Measures of Capacity.

1 liter (l) = 1 cubic decimeter (cbdm) = 1,000 cubic centimeters (cbcm) = 0.001 cubic meter (cbm) = 10 deciliters (dl) = 100 centiliters (cl) = 0.01 hektoliter (hl)

1 Hl = 10 Dl = 100 l = 1,000 dl = 10,000 cl = 26.42 gall

1 Dl = 10 l = 100 dl = 1,000 cl = 2.642 gall

1 l = 10 dl = 100 cl = 0.264 gall

4. Weights.

1 kilogram (kg) = 100 dekagrams (Dg) = 1000 grams (g)

1 gram = 10 decigrams (dg) = 100 centigrams (cg) = 1,000 milligrams (mg)

1 ton = 1,000 Kg = 100,000 Dg = 1,000,000 g = 2204.6 lbs

100 Kg = 10,000 Dg = 100,000 g = 220.46 lbs

1 Kg = 100 Dg = 1,000 g = 2.2046 lbs

73.

DEFINITION OF ELECTRIC UNITS.

The International Electric Congress, which was held in Paris, 1881 and 1884, adopted the following units for the measurements of the electro-motive force, resistance and current.

These practical legal electric units are based on the C. G. S. system.

C. G. S. is the product of space, mass and time.

C. is the expression for space in centimeters.

G. is the expression for mass in grams.

S. is the expression for time in seconds.

The unit of electro-motive force [E. M. F.] is called the *Volt*, and is equal to 10^8 C. G. S.

The unit of resistance is called the *Ohm*, and is equal to 10^9 C. G. S. It is equal to the resistance of a column of pure mercury of 106 cm. length and 1 square millimeter in cross section, at the temperature of 0° C.

The unit of current strength or of volume is called the *Ampère*. It is equal to 10^{-1} C. G. S. This unit represents the current produced by 1 volt flowing through a conductor of 1 ohm resistance.

The current of 1 ampère flowing through a conductor for one hour is called 1 *ampère hour*.

The unit of the current quantity is called the *Coulomb*. It is the quantity of electricity which flows in a current of 1 ampère in one second. The coulomb equals 10^{-1} C. G. S.

The unit of capacity is called the *Farad*. It represents the storage of 1 coulomb of electricity in a condenser. The farad equals 10^{-9} C. G. S. of capacity.

The unit of electric power is the *Watt*. It equals the product of 1 volt multiplied into one ampère, which equals 10^7 C. G. S.

74.

FOREIGN CURRENCIES.

Country.	Monetary Unit.	Value in U. S. Money
Austria.....	Florin = 100 Kreutzer	\$0.42
Belgium	Franc = 100 Centimes	\$0.19 $\frac{1}{2}$
Bolivia	Boliviano (Peso duro).....	\$0.61 $\frac{1}{2}$
China.....	Shanghai tael.....	\$0.91
"	Hankwan tael.....	\$1.03 $\frac{1}{2}$
Columbia.....	Peso.....	\$0.61 $\frac{1}{2}$
Denmark.....	Krona = 100 Oera.....	\$0.27 $\frac{1}{2}$
Ecuador	Sucre.....	\$0.61 $\frac{1}{2}$
England	Pound sterling = 20 shillings, 1 shilling = 12 pence.....	\$4.90
France	Franc = 100 Centimes.....	\$0.19 $\frac{1}{2}$
Germany.....	Mark = 100 Pfennige.....	\$0.24 $\frac{1}{2}$
Greece	Drachma = 100 Lepta.....	\$0.19 $\frac{1}{2}$
Holland.....	Gulden = 100 Cents.....	\$0.41
India	Rupce.....	\$0.33 $\frac{1}{2}$
Italy	Lira = 100 Centesimi.....	\$0.19
Japan	Yen	\$0.66 $\frac{1}{2}$
Mexico.....	Dollar.....	\$0.66 $\frac{1}{2}$
Norway.....	Krona = 100 Oere.....	\$0.27 $\frac{1}{2}$
Peru	Sol.....	\$0.61 $\frac{1}{2}$
Portugal.....	Milreis = 1,000 Reis.....	\$0.95
Russia.....	Rubel = 100 Kopeks	\$0.50
Spain.....	Peseta = 100 Centesimos	\$0.18 $\frac{1}{2}$
Sweden.....	Krona = 100 Oere.....	\$0.27 $\frac{1}{2}$
Switzerland.....	Franc = 100 Centimes	\$0.19 $\frac{1}{2}$
Tripoli.....	Mahup	\$0.55 $\frac{1}{2}$
Turkey.....	Plastre = 100 Cents.....	\$0.04 $\frac{1}{2}$
Venezuela	Bolivar.....	\$0.12 $\frac{1}{2}$
Central American States	Peso.....	\$0.61 $\frac{1}{2}$

B.—SPECIAL PART.

I. DYESTUFFS.

75. LIST OF COLORING MATTERS FOR SILK.

A.—SILK DYED IN NEUTRAL SOAP-BATH.

- YELLOW.** Auramine, Thioflavine T.
ORANGE. Chrysoidine, Phosphine.
RED. Cyclamine, Diamine Scarlet B, Fuchsine, Magdala Red, Rhodamine B and R, Safranin.
VIOLET. Alkali Violet, Crystal Violet, Ethyl Violet, Hofmann's Violet, Mauveine, Methyl Violet, Safranin Purple.
BLUE. Capri Blue, Methyl Blue, Methylene Blue, Nile Blue, Soluble Blue.
GREEN. Brilliant Green, Emerald Green, Malachite Green, Methyl Green, Victoria Green.
BROWN. Bismarck Brown.

B.—SILK DYED IN SOAP-BATH BROKEN (CURDLED) WITH ACETIC ACID.

- YELLOW.** Fast Yellow, Metanil Yellow, Picric Acid, Uranine.
ORANGE. Aurantia, Orange A, BG.
RED. Diamine Scarlet B, Eosine, Erythrine, Erythrosine, Phloxine, Rhodamine B and R, Rose Bengale, Rubramine.
VIOLET. Acid Violet 4 BN, Alkali Violet, Iris Violet, Violamine.
BLUE. Aniline Blue, Iris Blue, Night Blue, Victoria Blue, Soluble Blue.
GREEN. Brilliant Green, Victoria Green, Emerald Green.
BROWN. Toluylene Brown.
BLACK. Acid Black, Victoria Black B, Violet Black.

C.—SILK DYED IN SOAP-BATH BROKEN WITH SULFURIC ACID.

- YELLOW.** Azoflavine, Azo-Yellow, Azo-Acid-Yellow, Brilliant Yellow, Chinoline Yellow, Fast Yellow, Metanil Yellow, Naphthol Yellow, Picric Acid, Tartrazine, Victoria Yellow.
ORANGE. Orange A, D, BG, R.
RED. Acid Magenta, Archil Red, Azo-carmin, Cochineal Red, Crystal Ponceau, Diamine Scarlet B, Erythrine, Fast Red, Magdala Red, Palatin Red, Palatin Scarlet, Ponceau, Roxamine, Rubramine.
VIOLET. Acid Violet, 4 BN, 6 BN, S 2 R, S 7 B, Alkali Violet, Formyl Violet
BLUE. Aniline Blue, Fast Blue B, R; Indoin Blue, Induline, Night Blue, Patent Blue, Victoria Blue B, 4 R.
GREEN. Acid Victoria Green, Blue-Green Acid, Guinea Green.
BROWN. Acid Brown, Fast Brown, Naphthylamine Brown, Resorcline Brown.
BLACK. Acid Black, Naphthylamine Black, Victoria Black.
GREY. Nigrosine.

- D. SILK DYED IN ALKALINE BATH AND THEN BRIGHTENED UP WITH SULFURIC ACID.**
 Nicholson's blue.

76. LIST OF DYESTUFFS FOR WOOL.**I. DIRECT WOOL DYESTUFFS.****a. Wool dyed in neutral water bath :**

- YELLOW.** Auramine.
ORANGE. Chrysoidine, Phosphine.
RED. Cerise, Congo, Cyclamine, Fuchsin, Grenadine, Rubramine.
VIOLET. Crystal Violet, Ethyl Violet, Hofmann's Violet, Methyl Violet, Regina Violet, Safranin Purple.
BLUE. Indamine, Methylene Blue, Night Blue, Victoria Blue.
GREEN. Brilliant Green, Emerald Green, Malachite Green, Methyl Green, Victoria Green.
BROWN. Bismarck Brown, Manchester Brown.
BLACK. Violet Black.
GREY. Nigramine, Nigrosine.

b. Wool dyed in one bath with Alum, Tartar and Acetic Acid :
RED. Cyanosine, Eosine, Erythrosine, Ethyleosine, Phloxine, Rhodamine, Rose Bengale.

c. Wool dyed in neutral water bath with Glauber's Salt :
 Alkali Violet, Cotton Brown, Ethyl Violet, Sulfonazurine (blue).

d. Wool dyed in neutral water bath with Alum :
 Chrysoidine G, R; Chrysoline (yellow), Night Blue, Victoria Blue.

e. Wool dyed in neutral water bath with Common Salt :
 Naphthylamine Black, Toluylene Brown.

f. Wool dyed in neutral water bath after treatment with Sulfur :
 Auramine (yellow), Ethyl Green, Methyl Green, Thioflavine T.

g. Wool, chlorinated, dyed in neutral water bath :
 Fast Blue B, R; Induline.

II. ACID WOOL DYESTUFFS.**a. Wool dyed in one bath with Bisulfate of Soda or with Glauber's Salt and Sulfuric Acid :**

- YELLOW.** Azoflavine, Brilliant Yellow, Carbazol Yellow, Chinoline Yellow, Fast Yellow, Metanil Yellow, Naphthol Yellow, Picric Acid, Resorcin Yellow, Tartrazine.
ORANGE. Orange, G, GT, R, T, I, A, D, BG.
RED. Acid Magenta, Acid Red, Amarant, Apollo Red, Archil Red, Azo-benzole-fast-crimson, Azo carmine, Azo-coccine 2R, Azo-eosine, Azo-fuchsin B, G, Azo Red, Azorubine, Biebrich Scarlet, Bordeaux, Brilliant Croceine, Brilliant Red, Brilliant Scarlet, Carmoisine Chromotrope, Cloth Red G, Coccinine B, Cochineal Red, Congo P, Croceine, Croceine Scarlet, Crystal Ponceau, Diamine Scarlet, B, Double Brilliant Scarlet, Double Scarlet, Emin Red, Erythrine, Fast Red, Fast Acid Marron, New Coccine, Orceoline, Palatin Red, Palatin Scarlet, Ponceau, Pyrotine, Rose Pink, Roxamine, Rubramine, Scarlets, R, RR, 3 R. Wool Scarlet, Wool Ponceau.
VIOLET. Acid Violet 4 BN, 6 BN, SRR, S7B; Alkali Violet, Azo-acid Violet, Congo Violet, Fast Violet, Regina Violet, Red Violet 4 RS.
BLUE. Fast Acid Blue, Fast Blue B, R; Indazine M, Indigo Blue, Indigo Carmine, Iris Blue, Madras Blue, Marine Blue, Navy Blue, Night Blue, Patent Blue, Soluble Blue, Toluidine Blue, Victoria Blue B, 4R; Wool Blue S.

GREEN. Acid Victoria Green, Blue Green Acid, Guinea Green.
BROWN. Acid Brown, Fast Brown, Naphthylamine Brown, Resorcine Brown.
BLACK. Acid Black, Anthracite Black, Naphthol Black, Naphthylamine Black, Victoria Black.

III. WOOL DYED IN ALKALINE BATH, AFTERWARDS BRIGHTENED UP IN ACIDULATED BATH.

Nicholson's blue.

IV. DYESTUFFS FOR MORDANTED WOOL.

1. Alizarine colors :

Color.	Alum and Tartar.	Potash, Bichromate and Tartar.
Alizarine for Red, WB, (powd.)	Crimson.	Bluish Bordeaux.
" " WBB,	Crimson.	Bluish Bordeaux
" " WY, (powd.)	(more Bluish).	(more Bluish).
" " WYY,	Scarlet.	{ Yellowish
" " WA, (powd.)	Scarlet.	Bordeaux.
" " WBN,	(more Yellowish)	Yell. Bordeaux
" " WYN,	Scarlet.	(more Yellowish).
Alizarine Orange, WO,	Crimson.	Bluish Bordeaux
" " SWO, (powd.) }	Scarlet.	Yell. Bordeaux.
Alizarine Blue, SB, {	Scarlet.	Bluish Bordeaux
(powd.) } soluble	Orange.	Yell. Bordeaux.
" " R,	Orange.	Bismarck Brown.
" " B,	—	Pure Blue.
" " N3R,	Dark Purple.	Red Blue.
" " NR,	Reddish Purple.	Pure Blue.
" " NB,	Bluish Purple.	{ Extra Reddish
" " NG,	—	Blue.
" " JSW,	—	Reddish Blue.
Alizarine Cyanine,	Bright Garnet.	{ Pure Blue.
Alizarine Garnet,	—	{ Greenish Blue.
Alizarine Green, SW, (powd.) }	—	Indigo Blue.
Alizarine Brown, O, {	—	Blue.
SO, { powder	—	Maroon.
" " N,	—	Bluish Green.
Alizarine Yellow, N,	Greenish Yellow.	Reddish Brown
" " NA,	Golden Yellow.	Yellowish Brown
Alizarine Black, SW,	—	Greenish Yellow.
" " WD,	—	Golden Yellow.
" " WB,	—	Black.
" " SB, (powder)	—	Jet Black.
		Blue Black.
		Blue Black.

2. Colors applied like Alizarine dyestuffs, also used in mixtures with them :

Carbazol Yellow, Chrome Black, Chrome Blue, Chrome Bordeaux, Chrome Orange, Chrome Prune, Chrome Red, Coeruleine (Green), Fast Dark Green (Resorcine), Fast Violet, Formyl Violet, Galamine Blue, Galleine (Purple), Galloeyanine (Purple), Gallo-

flavine (Yellow), Prune (Purple), Victoria Violet, R; SR, (powder); B, E, Viridine S, (powder), [dark green, very fast].

3. Colors for Wool Mordanted with Chromefluorid or Alum :
Diamond Black, Diamond Flavine, Diamond Green, Diamond Orange, Diamond Yellow.

4. Nitroso dyestuffs dyed with addition of Iron Salts :
Dioxine, Gambine R, Y, Naphthol Green B.

77. LIST OF COLORING MATTERS FOR COTTON.

A.—DIRECT COTTON DYESTUFFS.

1. Cotton dyed in neutral water bath :

- YELLOW.** Direct Yellow, Primuline, Thioflavine S, Yellow B.
ORANGE. Direct Orange, Primuline Orange, Toluylene Orange.
RED. Congo, Cotton Bordeaux, Erica B, Hessian Brilliant Purple, Primuline Red, Rhodamine S, Safranin.
VIOLET. Azo-mauve.
BLUE. Benzo Blue S Extra, Brilliant Azurine 5G, Indamine Blue, Indophenine Extra, Java Blue, Methylene Blue, Sulfonazurine, Toluylene Blue.
BROWN. Alkali Brown, Bismarck Brown E, Cachou de Laval, Catechu Brown, Congo Brown, Primuline Brown.
GREY. New Grey.

2. Cotton dyed with Alum and Soda :

Naphthol Yellow, Orange GO, GOR, Scarlet SR, SRR, S3R, Cochineal Red RR, Methyl Violet 6B (crystals), BBN, Cotton Blue.

3. Cotton dyed in alkaline bath with addition of Glauber's Salt or Sodium Phosphate, Common Salt, Sodium Carbonate, Potassium Carbonate, Sodium Silicate, Sodium Stannate, Sodium Aluminate :

- YELLOW.** Alkali Yellow, Brilliant Yellow, Carbazol Yellow, Chrysamine, Chrysophenine, Congo Yellow, Cotton Yellow G, R, Diamine Yellow, Direct Yellow, Hessian Yellow, Kresotine Yellow, Mikado Yellow, Sulfanil Yellow, Thiazol Yellow, Thioflavine, Turmerine.
ORANGE. Benzo Orange R, Congo Orange, Cotton Orange S, Direct Orange, Mikado Orange, Toluylene Orange.
RED. Atlas Red, Azamine 4B, Benzo Purpurine B, 4B, 6B, 10B, Brilliant Congo, Congo, Cotton Red, Delta Purpurine, Diamine Fast Red, Diamine Red, Diamine Scarlet, Erica, Hessian Purple, Naphthylene Red, Rosazurine, Salmon Red, Salm Red, St. Denis Red, Stilben Red, Titan Pink, Titan Scarlet.
VIOLET. Azo Violet, Congo Corinth, Congo Violet, Diamine Violet N, Heliotrop, Hessian Violet, Violet Black.
BLUE. Azo Blue, Benzo Azurine, Benzo Black Blue, Benzo Indig Blue, Brilliant Azurine, Congo Fast Blue, Diamine Blue, Indolin Blue, Sulfon Azurine.
BROWN. Benzo Brown Benzo Olive, Congo Brown, Cotton Brown, Diamine Brown, Hessian Brown, Mikado Brown, Toluylene Brown.
BLACK. Benzo Black, Diamine Blue Black, Diamine Black, Nyanza Black, Tabora Black.
GREY. Benzo Grey.

B.—DYESTUFFS FOR MORDANTED COTTON.

1. Cotton mordanted with Tannic Acid and Tartar Emetic :
 YELLOW. Auramine, Benzoflavine, Thioflavine T.
 ORANGE. Chrysoidine, Phosphine.
 RED. Cerise, Cotton Cardinal, Cotton Scarlet, Fuchsine, Magenta, Neutral Red, Phenosafranine, Pyronine, Rhodamine B, S, Safranine.
 VIOLET. Ethyl Violet, Hofmann's Violet, Methyl Violet RR, BBN, 6 B, Neutral Violet, Safranine Purple.
 BLUE. Bavarian Blue, Capri Blue, China Blue, Fast Blue, Indoin Blue R, BB, Indophenol, Methylene Blue, Methyl Water Blue, Night Blue, Nile Blue, Paraphenylene Blue, Soluble Blues, Toluidine Blue, Victoria Blue B, 4R.
 GREEN. Brilliant Green, Emerald Green, Malachite Green, Methyl Green, Victoria Green.
 BROWN. Bismarck Brown, Canelle, Manchester Brown.
 GREY. Induline, Nigrosine.
2. Alizarine dyestuffs for cotton :

Alizarine V (Bluish Pink),	Alizarine Blue SB (Paste),
" VD (Bluish Red),	" " (Powder),
" RB (Turkey Red),	" Green,
" RN (Scarlet),	" Brown,
" RS (Scarlet, Extra),	" Orange,
" Garnet,	Viridine (Green).
3. Other dyestuffs for mordanted cotton :
 Galleine, Gallocyanine, Resorcine Green.

78.

THE MORDANTING OF WOOL.

Although the woolen fibre has such strong affinity to the majority of the known artificial coloring matters, that it can be dyed directly without any chemical preparation (mordanting), yet the colors thus produced have the disadvantage of being not fast against light, fulling, etc. While in the last years the manufacturers of coal-tar colors competed with each other in discovering so-called direct dyestuffs, the application of which is very simple, and was dwelt upon at length in a series of articles by the authors in the *Textile Colorist*, 1892, p. 2, and following, it is now their endeavor to bring into the market dyes which produce fast colors on mordanted textile fabrics.

Though the dyeing methods for these fast colors are more intricate and require greater care than the application of the direct colors, still they are used more and more on account of the superior results obtained.

The following methods are generally used for mordanting wool :

A.—ALUMINUM SALTS.

Alum and aluminum sulfate are generally used in combination with tartar. For 100 lbs. of wool a solution is prepared of 10 lbs. of alum and $7\frac{1}{2}$ lbs. of tartar ; or, 8 lbs. of aluminum sulfate and 7 lbs. of tartar.

The wool is entered into the cold bath, which is gradually heated in 1 to $1\frac{1}{2}$ hours to the boiling point. Another mordant is prepared by dissolving 10 lbs. of alum, 3 lbs. of tartar, 2 lbs. of oxalic acid.

The process of mordanting is the same as above and is mostly used for dye woods, resorcine colors and alizarine colors.

B.—CHROME SALTS.**1. Bichromates :**

The following mordant is mostly used : For 100 lbs. of wool, 3 lbs. of potassium bichromate and $2\frac{1}{2}$ lbs. of tartar. In these mordants the goods are boiled for $1\frac{1}{2}$ hours. To insure uniform shades, the goods should be entered into the cold bath, the temperature of which is to be raised in 1 to $1\frac{1}{2}$ hours to the boiling point and kept there for 45 to 60 minutes. Instead of potassium bichromate the less expensive sodium-compound may be used.

2. Chrome Fluorid :

For 100 lbs. of wool, 4 lbs. of chrome fluorid are dissolved in the necessary quantity of water. The goods are boiled in this liquid for $1\frac{1}{2}$ hours.

C.—TIN SALTS.

The tin lakes produced by tin salts as mordant possess bright and vivid shades, but these lakes being not fast against fulling, alum and tartar are generally used in combination with them.

For 100 lbs. of wool are used : 6 lbs. of stannous chlorid (tin crystals), and 8 lbs. of oxalic acid ; or, 6 lbs. of stannous chlorid and 4 lbs. of tartar ; or, 10 lbs. of alum, 3 lbs. of tartar, 2 lbs. of oxalic acid and $\frac{1}{2}$ to 1 lb. stannous chlorid.

The goods are boiled in these mordants for $1\frac{1}{2}$ hours.

D.—SULFUR.

Sulfur is precipitated on the fibre from sodium thio-sulfate by means of muriatic acid. This impregnation with amorphous sulfur gives the fibre special affinity for some basic dye stuffs ; for instance, methyl green, malachite green, etc.

E.—CHLORIN.

Wool after being treated for $\frac{1}{2}$ -hour in a bath containing 3 to 10% of sulfuric acid, is entered into a weak, perfectly clear and cold solution of lime hypochlorite (bleaching powder), the temperature of which is gradually raised to the boiling point. The wool thus mordanted is dyed with acid dyestuffs without the addition of Glauber's salt and sulfuric acid.

79.**THE MORDANTING OF COTTON.**

The vegetable fibre has only slight affinity for the artificial dye-stuffs and is dyed directly, without the use of mordants, only by a comparatively small number of coloring matters.

The oldest and mostly used method for mordanting cotton is the following :

A.—TANNIC ACID AND TARTAR EMETIC.

According to Knecht's investigation, cotton absorbs the greatest quantity of tannic acid if the material is entered into the boiling bath containing the solution of tannic acid. The liquid is then allowed to stand without further heating for three hours. During this time the cotton should be frequently turned. For 100 lbs. of cotton are required 20 lbs. of sumac, or 3 lbs. of tannine. After steeping for three hours and wringing out, the material is passed through a bath which contains 1 lb. of tartar emetic or any other antimony salt.

B.—MORDANTING FOR ALIZARINE COLORS.

The application of alizarine colors to cotton is more laborious than that of other dyestuffs, but the colors obtained with alizarines are exceedingly fast in every respect, and offer important advantages over the direct dyestuffs.

1. Aluminum salts (Turkey red on cotton):

The cotton is boiled in a weak soda-ash solution, thoroughly rinsed, wrung out and impregnated with a mixture of 10 parts Turkey red oil (F) and 90 parts of water. The goods are wrung out and dried at 110 to 120° F. This operation is several times repeated. The dried goods are then passed through a bath of aluminum acetate of 6° Bé., and worked therein till uniformly permeated, wrung out and dried at 110 to 120° F. After repeating the operation once or twice, the cotton is worked for $\frac{1}{4}$ hour in a bath containing in 200 parts of water 1 part of carbonate of lime (chalk) and then thoroughly rinsed and dyed. If aluminum sulfate is employed instead of the acetate, slight changes are necessary.

2. Sumac and alum:

100 lbs. of cotton are left over night in a bath of 20 to 25% of sumac dissolved in the necessary quantity of water. Then they are wrung out and without washing or drying they are entered into a bath prepared by mixing the solution of 8 parts of alum in 48 parts of water and 1 part of calcined soda in 6 parts of water, and diluting the mixture to 6° Bé. The goods are left in this mordant over night, then rinsed and dyed.

3. Chrome chlorid (for light shades):

The goods are left over night in a solution of chrome chlorid of 20° Bé., then rung out, rinsed and dyed.

4. Turkey red oil and chrome chlorid:

After being oiled in a bath containing 1 part Turkey red oil (F) and 9 parts of water, the goods are dried and then left over night in a solution of chrome chlorid of 20° Bé. They are wrung out, rinsed and dyed.

5. Sumac and chrome chlorid:

The goods are entered into a boiling solution of 10 parts of sumac extract of 30° Bé. in 1,000 parts of water and left therein over night. They are then wrung out and left for 4 hours in a solution of chrome chlorid of 20° Bé., well washed and dyed.

6. Turkey red oil, sumac and chrome chlorid:

The goods are oiled in a bath of 1 part of Turkey red oil (F) and 9 parts of water, dried and treated with sumac and chrome chlorid as described in No. 5.

7. Chrome acetate:

The goods are boiled for 1 hour in a bath of 20 parts of chrome acetate of 20° Bé. and 1,000 parts of water.

8. Turkey red oil and chrome acetate:

The goods are oiled in a bath of 1 part of Turkey red oil (F) and 9 parts of water, dried and then boiled for 1 hour under continuous stirring in a bath containing 20 parts of chrome acetate of 20° Bé. and 1,000 parts of water. After washing well, the goods are dyed. For dark shades a repetition of mordanting is necessary.

9. Alkaline chrome mordant:

The goods are left for 12 hours in a solution of 25 pts. of chrome acetate of 20° Bé., 32 pts. of caustic soda of 38° Bé., 1 pt. of glycerol

(glycerine) of 30° Bé., and 42 pts. of water. They are then wrung out, rinsed and dyed.

10. Iron salts :

The goods are mordanted in a solution of iron pyrolignite of 8° Bé., exposed to the air for 48 hours and passed through a chalk bath, rinsed and dyed.

80.

THE MORDANTING OF SILK.

Silk is dyed with artificial dyestuffs almost exclusively without any mordant. Only for weighting, the fibre has to be prepared with certain chemicals, but a description of these methods would be beyond the limits of our book. We describe here some of the modern methods of mordanting silk for alizarine dyestuffs, which thus produce colors fast against light, soap and acid.

1. Alum and sodium silicate :

A solution of 60 ozs. of alum and 6 ozs. of soda crystals in 10 gallons of water is heated until the solution is clear; then the goods are entered, turned for $\frac{1}{4}$ hour, and left in the bath for 12 hours. The goods are wrung out and worked for $\frac{1}{4}$ hour in a solution of sodium silicate of $\frac{1}{4}$ ° Bé., then well washed and dyed.

2. Chrome chlorid and sodium silicate :

The goods are left for 6 hours in a solution of chrome chlorid of 23° Bé., then washed and entered into a cold bath of sodium silicate of 1° Bé. After being turned for $\frac{1}{4}$ hour and being well washed, they are dyed. For dark shades the goods remain for 12 hours in the chrome chlorid.

3. Nitrate of iron :

The silk is turned for $\frac{1}{2}$ hour in a solution of nitrate of iron of 30° Bé., washed, soaped for $1\frac{1}{2}$ hours with 10% Marseille soap at 165 to 170° F., and washed again. To obtain blue shades, the goods are passed through a bath containing 10% of potassium ferrocyanid and 12% of muriatic acid of 20° Bé. They are then entered into a boiling catechu bath containing 50% of catechu, left there for two hours, washed and dyed.

II. SUGAR.

In the saccharometer of Soleil-Ventzke a deviation of 100.0 degrees is produced by a solution containing 26.048 grams of chemically pure cane sugar in 100 cc., which is observed in a tube of 200 mm. length. The specific gravity of this solution is 1.100 at 17.5° C.

In order to find the amount of sugar in 100 cc. of a solution, the number of degrees found by direct polarization is to be multiplied by 0.26048 grams.

If 26.048 grams of a substance are dissolved in 100 cc. and this solution is polarized, the percentage of cane sugar is directly indicated by the degrees read.

For other solutions it is necessary to ascertain the specific gravity for the calculation of the percentage of cane sugar.

As the specific rotatory power of cane sugar solutions increases between certain limits with a decrease of the concentration a correction of -0.1° is to be used for readings between 17° and 84° .

The following tables will be found useful for polariscopic work on plantations and in refineries.

81. COMPARISON OF THE SACCHAROMETER DEGREES WITH THE DEGREES OF BEAUMÉ'S AREOMETER.

The degrees of the saccharometer of Balling, improved by Brix, indicate the percentage of cane sugar in solution.

Per cent. of Cane Sugar.	Specific gravity.	Degrees Beaumé.	Per cent. of Cane Sugar.	Specific gravity.	Degrees Beaumé.	Per cent. of Cane Sugar.	Specific gravity.	Degrees Beaumé.
0.0	1.000	0.0	9.0	1.036	5.1	18.0	1.074	10.1
0.5	1.002	0.3	9.5	1.038	5.4	18.5	1.077	10.4
1.0	1.004	0.6	10.0	1.040	5.7	19.0	1.079	10.7
1.5	1.006	0.85	10.5	1.042	5.9	19.5	1.081	11.0
2.0	1.008	1.1	11.0	1.044	6.2	20.0	1.083	11.3
2.5	1.010	1.4	11.5	1.046	6.5	20.5	1.086	11.6
3.0	1.012	1.7	12.0	1.049	6.8	21.0	1.088	11.8
3.5	1.014	2.0	12.5	1.051	7.1	21.5	1.090	12.1
4.0	1.016	2.3	13.0	1.053	7.4	22.0	1.092	12.4
4.5	1.018	2.55	13.5	1.055	7.6	22.5	1.095	12.7
5.0	1.020	2.8	14.0	1.057	7.9	23.0	1.097	13.0
5.5	1.022	3.1	14.5	1.059	8.2	23.5	1.099	13.2
6.0	1.024	3.4	15.0	1.061	8.5	24.0	1.101	13.5
6.5	1.026	3.7	15.5	1.063	8.8	24.5	1.104	13.8
7.0	1.028	4.0	16.0	1.066	9.0	25.0	1.106	14.1
7.5	1.030	4.25	16.5	1.068	9.3	25.5	1.108	14.3
8.0	1.032	4.5	17.0	1.070	9.6	26.0	1.111	14.6
8.5	1.034	4.8	17.5	1.072	9.9	26.5	1.113	14.9

81—Continued.

Per cent. of Cane Sugar.	Specific gravity.	Degrees Beaumé.	Per cent. of Cane Sugar.	Specific gravity.	Degrees Beaumé.	Per cent. of Cane Sugar.	Specific gravity.	Degrees Beaumé.
27.0	1.115	15.2	48.5	1.225	26.9	69.5	1.348	37.9
27.5	1.118	15.5	49.0	1.227	27.2	70.0	1.351	38.1
28.0	1.120	15.7	49.5	1.230	27.4	70.5	1.354	38.4
28.5	1.122	16.0	50.0	1.233	27.7	71.0	1.357	38.6
29.0	1.125	16.3	50.5	1.236	28.0	71.5	1.360	38.9
29.5	1.127	16.6	51.0	1.238	28.2	72.0	1.364	39.1
30.0	1.130	16.8	51.5	1.241	28.5	72.5	1.367	39.4
30.5	1.132	17.1	52.0	1.244	28.8	73.0	1.370	39.6
31.0	1.134	17.4	52.5	1.247	29.0	73.5	1.373	39.9
31.5	1.137	17.7	53.0	1.249	29.3	74.0	1.376	40.1
32.0	1.139	17.95	53.5	1.252	29.6	74.5	1.380	40.4
32.5	1.142	18.2	54.0	1.255	29.8	75.0	1.383	40.6
33.0	1.144	18.5	54.5	1.258	30.1	75.5	1.386	40.9
33.5	1.147	18.8	55.0	1.261	30.4	76.0	1.389	41.1
34.0	1.149	19.05	55.5	1.264	30.6	76.5	1.393	41.4
34.5	1.152	19.3	56.0	1.267	30.9	77.0	1.396	41.6
35.0	1.154	19.6	56.5	1.269	31.2	77.5	1.399	41.9
35.5	1.157	19.9	57.0	1.272	31.4	78.0	1.402	42.1
36.0	1.159	20.1	57.5	1.275	31.7	78.5	1.406	42.4
36.5	1.162	20.4	58.0	1.278	31.9	79.0	1.409	42.6
37.0	1.164	20.7	58.5	1.281	32.2	79.5	1.412	42.9
37.5	1.167	21.0	59.0	1.284	32.5	80.0	1.416	43.1
38.0	1.169	21.2	59.5	1.287	32.7	80.5	1.419	43.3
38.5	1.172	21.5	60.0	1.290	33.0	81.0	1.422	43.6
39.0	1.174	21.8	60.5	1.293	33.2	81.5	1.426	43.8
39.5	1.177	22.05	61.0	1.296	33.5	82.0	1.429	44.1
40.0	1.179	22.3	61.5	1.299	33.8	82.5	1.433	44.3
40.5	1.182	22.6	62.0	1.302	34.0	83.0	1.436	44.6
41.0	1.185	22.9	62.5	1.305	34.3	83.5	1.440	44.8
41.5	1.187	23.1	63.0	1.308	34.5	84.0	1.443	45.1
42.0	1.190	23.4	63.5	1.311	34.8	84.5	1.446	45.3
42.5	1.192	23.7	64.0	1.314	35.1	85.0	1.450	45.5
43.0	1.195	23.95	64.5	1.317	35.3	85.5	1.453	45.8
43.5	1.198	24.2	65.0	1.320	35.6	86.0	1.457	46.0
44.0	1.200	24.5	65.5	1.323	35.8	86.5	1.460	46.3
44.5	1.203	24.8	66.0	1.326	36.1	87.0	1.464	46.5
45.0	1.206	25.0	66.5	1.329	36.3	87.5	1.467	46.7
45.5	1.208	25.3	67.0	1.332	36.6	88.0	1.471	47.0
46.0	1.211	25.6	67.5	1.335	36.85	88.5	1.474	47.2
46.5	1.214	25.8	68.0	1.338	37.1	89.0	1.478	47.45
47.0	1.216	26.1	68.5	1.341	37.4	89.5	1.481	47.7
47.5	1.219	26.4	69.0	1.345	37.6	90.0	1.485	47.9
48.0	1.222	26.6						

82. CORRECTION FOR THE READINGS OF BRIX & BALLING'S SACCHAROMETER, ON ACCOUNT OF TEMPERATURE.

Temperature.		Per cent. of cane sugar in solution.													
°C.	°F.	0	5	10	15	20	25	30	35	40	50	60	70	75	
Number of degrees to be subtracted from degrees read.															
0°	32°	0.27	0.30	0.41	0.52	0.62	0.72	0.82	0.92	0.98	1.11	1.22	1.25	1.29	
5	41	0.23	0.30	0.37	0.44	0.52	0.59	0.65	0.72	0.75	0.80	0.88	0.91	0.94	
10	50	0.20	0.26	0.29	0.33	0.36	0.39	0.42	0.45	0.48	0.50	0.54	0.58	0.61	
11	51.8	0.18	0.23	0.26	0.28	0.31	0.34	0.36	0.39	0.41	0.43	0.47	0.50	0.53	
12	53.6	0.16	0.20	0.22	0.24	0.26	0.29	0.31	0.33	0.34	0.36	0.40	0.42	0.46	
13	55.4	0.14	0.18	0.19	0.21	0.22	0.24	0.26	0.27	0.28	0.29	0.33	0.35	0.39	
14	57.2	0.12	0.15	0.16	0.17	0.18	0.19	0.21	0.22	0.22	0.23	0.26	0.28	0.32	
15	59.0	0.09	0.11	0.12	0.14	0.14	0.15	0.16	0.17	0.16	0.17	0.19	0.21	0.25	
16	60.8	0.06	0.07	0.08	0.09	0.10	0.10	0.11	0.12	0.12	0.14	0.14	0.16	0.18	
17	62.6	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.06	
Number of degrees to be added to degrees read.															
18	64.4	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	
19	66.2	0.06	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.08	0.06	
20	68.0	0.11	0.14	0.15	0.17	0.17	0.18	0.18	0.18	0.19	0.19	0.18	0.15	0.11	
21	69.8	0.16	0.20	0.22	0.24	0.24	0.25	0.25	0.25	0.26	0.26	0.25	0.22	0.18	
22	71.6	0.21	0.26	0.29	0.31	0.31	0.32	0.32	0.32	0.33	0.34	0.32	0.29	0.25	
23	73.4	0.27	0.32	0.35	0.37	0.38	0.39	0.39	0.39	0.40	0.42	0.39	0.36	0.33	
24	75.2	0.32	0.38	0.41	0.43	0.44	0.46	0.46	0.47	0.47	0.50	0.46	0.43	0.40	
25	77.0	0.37	0.44	0.47	0.49	0.51	0.53	0.54	0.55	0.55	0.58	0.54	0.51	0.48	
26	78.8	0.43	0.50	0.54	0.56	0.58	0.60	0.61	0.62	0.62	0.66	0.62	0.58	0.55	
27	80.6	0.49	0.57	0.61	0.63	0.65	0.68	0.68	0.69	0.70	0.74	0.70	0.65	0.62	
28	82.4	0.56	0.64	0.68	0.70	0.72	0.76	0.76	0.78	0.78	0.82	0.78	0.72	0.70	
29	84.2	0.63	0.71	0.75	0.78	0.79	0.84	0.84	0.86	0.86	0.90	0.86	0.80	0.78	
30	86.0	0.70	0.78	0.82	0.87	0.87	0.92	0.92	0.94	0.94	0.98	0.94	0.88	0.86	
35	95.0	1.10	1.17	1.22	1.24	1.30	1.32	1.33	1.35	1.36	1.39	1.34	1.27	1.25	
40	104.0	1.50	1.61	1.67	1.71	1.73	1.79	1.79	1.80	1.82	1.83	1.78	1.69	1.65	

83. POLARIZATION OF SUGAR LIQUORS WITHOUT REGARD TO THE DENSITY OF THE JUICES.

A.—WITHOUT SUBACETATE OF LEAD.

Saccharo- metric degrees.	Per cent. Sugar.	° Degrees.	Per cent. Sugar.	Saccharo- metric Degrees.	Per cent. Sugar.	° Degrees.	Per cent. Sugar.
1	0.26	....	....	7	1.81	1	0.03
2	0.52	....	....	8	2.07	2	0.05
3	0.78	....	....	9	2.32	3	0.08
4	1.04	....	....	10	2.58	4	0.10
5	1.30	....	....	11	2.83	5	0.13
6	1.55	....	....	12	3.09	6	0.15

83—Continued.

Saccharo- metric degrees.	Per cent. Sugar.	° Degrees.	Per cent. Sugar.	Saccharo- metric degrees.	Per cent. Sugar.	° Degrees.	Per cent. Sugar.
13	3.34	7	0.18	57	14.05	7	0.16
14	3.60	8	0.20	58	14.28	8	0.19
15	3.85	9	0.23	59	14.51	9	0.21
16	4.10	.....	.....	60	14.74	.....	.....
17	4.35	.....	.....	61	14.98	.....	.....
18	4.61	.....	.....	62	15.21	.....	.....
19	4.86	.....	.....	63	15.44	.....	.....
20	5.11	.....	.....	64	15.67	.....	.....
21	5.35	.....	.....	65	15.90	.....	.....
22	5.60	.....	.....	66	16.13	.....	.....
23	5.86	.....	.....	67	16.36	.....	.....
24	6.11	.....	.....	68	16.58	.....	.....
25	6.36	.....	.....	69	16.81	.....	.....
26	6.61	.....	.....	70	17.04	.....	.....
27	6.85	.....	.....	71	17.27	.....	.....
28	7.09	1	0.02	72	17.49	.....	.....
29	7.34	2	0.05	73	17.72	.....	.....
30	7.59	3	0.07	74	17.95	.....	.....
31	7.83	4	0.10	75	18.17	.....	.....
32	8.08	5	0.12	76	18.40	.....	.....
33	8.33	6	0.15	77	18.62	.....	.....
34	8.57	7	0.17	78	18.85	.....	.....
35	8.81	8	0.20	79	19.07	.....	.....
36	9.05	9	0.22	80	19.29	.....	.....
37	9.29	.....	.....	81	19.52	1	0.02
38	9.54	.....	.....	82	19.74	2	0.04
39	9.78	.....	.....	83	19.96	3	0.07
40	10.02	.....	.....	84	20.18	4	0.09
41	10.26	.....	.....	85	20.41	5	0.11
42	10.50	.....	.....	86	20.63	6	0.13
43	10.74	.....	.....	87	20.85	7	0.16
44	10.98	.....	.....	88	21.07	8	0.18
45	11.22	.....	.....	89	21.29	9	0.20
46	11.46	.....	.....	90	21.51	.....	.....
47	11.69	.....	.....	91	21.73	.....	.....
48	11.93	.....	.....	92	21.95	.....	.....
49	12.17	.....	.....	93	22.16	.....	.....
50	12.40	.....	.....	94	22.38	.....	.....
51	12.64	1	0.02	95	22.60	.....	.....
52	12.88	2	0.05	96	22.82	.....	.....
53	13.11	3	0.07	97	23.03	.....	.....
54	13.35	4	0.09	98	23.25	.....	.....
55	13.58	5	0.12	99	23.46	.....	.....
56	13.81	6	0.14	100	23.68	.....	.....

83—Continued. B.—WITH SUBACETATE OF LEAD.

Saccharo- metric Degrees.	Per cent. Sugar.	° Degrees.	Per cent. Sugar.	Saccharo- metric Degrees.	Per cent. Sugar.	° Degrees.	Per cent. Sugar.
1	0.29	1	0.03	51	13.84	1	0.03
2	0.57	2	0.06	52	14.09	2	0.05
3	0.86	3	0.09	53	14.35	3	0.18
4	1.14	4	0.11	54	14.60	4	0.10
5	1.42	5	0.14	55	14.86	5	0.13
6	1.71	6	0.17	56	15.11	6	0.15
7	1.99	7	0.20	57	15.37	7	0.18
8	2.27	8	0.23	58	15.62	8	0.20
9	2.55	9	0.26	59	15.87	9	0.23
10	2.83	....	....	60	16.13	....	....
11	3.11	....	....	61	16.38	....	....
12	3.39	1	0.03	62	16.63	....	....
13	3.67	2	0.06	63	16.88	....	....
14	3.95	3	0.08	64	17.13	....	....
15	4.23	4	0.11	65	17.38	....	....
16	4.51	5	0.14	66	17.63	....	....
17	4.78	6	0.17	67	17.88	....	....
18	5.06	7	0.19	68	18.13	....	....
19	5.33	8	0.22	69	18.38	....	....
20	5.61	9	0.25	70	18.62	....	....
21	5.88	....	....	71	18.87	....	....
22	6.15	....	....	72	19.12	1	0.02
23	6.43	....	....	73	19.36	2	0.05
24	6.70	....	....	74	19.61	3	0.07
25	6.97	....	....	75	19.85	4	0.10
26	7.24	....	....	76	20.10	5	0.12
27	7.51	....	....	77	20.34	6	0.15
28	7.78	....	....	78	20.58	7	0.17
29	8.05	1	0.03	79	20.83	8	0.20
30	8.32	2	0.05	80	21.07	9	0.22
31	8.59	3	0.08	81	21.31	....	....
32	8.86	4	0.11	82	21.55	....	....
33	9.12	5	0.13	83	21.79	....	....
34	9.39	6	0.16	84	22.03	....	....
35	9.66	7	0.19	85	22.27	....	....
36	9.92	8	0.21	86	22.51	....	....
37	10.19	9	0.24	87	22.75	....	....
38	10.45	....	....	88	22.99	....	....
39	10.71	....	....	89	23.23	....	....
40	10.98	....	....	90	23.46	....	....
41	11.24	....	....	91	23.70	....	....
42	11.50	....	....	92	23.94	....	....
43	11.76	....	....	93	24.17	....	....
44	12.03	....	....	94	24.41	....	....
45	12.29	....	....	95	24.64	....	....
46	12.55	....	....	96	24.88	....	....
47	12.80	....	....	97	25.11	....	....
48	13.06	....	....	98	25.35	....	....
49	13.32	....	....	99	25.58	....	....
50	13.58	....	....	100	25.81	....	....

84.—POLARIZATION OF SUGAR LIQUORS, WITH REFERENCE TO THE DENSITY OF THE JUICES (WITHOUT SUBACETATE OF LEAD.)

Saccharo- metric Degrees.	Density of Juice in Degrees, Brix.									
	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
1	0.260	0.260	0.259	0.259	0.258	0.258	0.257	0.257	0.256	0.256
2	0.521	0.520	0.519	0.518	0.517	0.516	0.515	0.514	0.513	0.512
3	0.781	0.780	0.778	0.777	0.775	0.774	0.772	0.771	0.769	0.768
4	1.042	1.040	1.038	1.036	1.034	1.032	1.030	1.028	1.026	1.024
5	1.302	1.300	1.297	1.295	1.292	1.290	1.287	1.285	1.282	1.280
6	1.563	1.560	1.557	1.554	1.551	1.548	1.545	1.542	1.539	1.536
7	1.823	1.820	1.816	1.813	1.809	1.806	1.802	1.799	1.795	1.792
8	2.084	2.080	2.076	2.072	2.068	2.064	2.060	2.056	2.052	2.048
9	2.344	2.340	2.335	2.331	2.326	2.322	2.317	2.312	2.308	2.304
10	2.605	2.600	2.595	2.590	2.585	2.580	2.575	2.575	2.565	2.559

	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5
1	0.255	0.255	0.254	0.254	0.253	0.253	0.252	0.252	0.251	0.251
2	0.511	0.510	0.509	0.508	0.507	0.506	0.505	0.504	0.503	0.502
3	0.766	0.765	0.763	0.762	0.760	0.759	0.757	0.756	0.754	0.753
4	1.022	1.020	1.018	1.016	1.014	1.012	1.010	1.008	1.006	1.004
5	1.277	1.275	1.272	1.270	1.267	1.265	1.262	1.260	1.257	1.255
6	1.533	1.530	1.527	1.524	1.521	1.518	1.515	1.512	1.509	1.506
7	1.788	1.785	1.781	1.778	1.774	1.771	1.767	1.763	1.760	1.757
8	2.044	2.040	2.036	2.032	2.027	2.023	2.019	2.015	2.011	2.007
9	2.299	2.295	2.290	2.285	2.281	2.276	2.272	2.267	2.263	2.258
10	2.554	2.549	2.544	2.539	2.534	2.529	2.524	2.519	2.514	2.509

	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5
1	0.250	0.250	0.249	0.249	0.248	0.248	0.247	0.247	0.246	0.246
2	0.501	0.500	0.499	0.498	0.497	0.496	0.495	0.494	0.493	0.492
3	0.751	0.750	0.748	0.747	0.745	0.744	0.742	0.741	0.739	0.738
4	1.002	1.000	0.998	0.996	0.994	0.992	0.990	0.988	0.986	0.984
5	1.252	1.250	1.247	1.245	1.242	1.240	1.237	1.235	1.232	1.230
6	1.503	1.500	1.497	1.494	1.491	1.488	1.484	1.482	1.479	1.476
7	1.753	1.750	1.746	1.743	1.739	1.735	1.732	1.728	1.725	1.722
8	2.003	1.999	1.995	1.991	1.987	1.983	1.979	1.975	1.971	1.967
9	2.254	2.249	2.245	2.240	2.236	2.231	2.227	2.222	2.218	2.213
10	2.504	2.499	2.494	2.489	2.484	2.479	2.474	2.469	2.464	2.459

	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5
1	0.245	0.245	0.244	0.244	0.243	0.243	0.242	0.242	0.241	0.241
2	0.491	0.490	0.489	0.488	0.487	0.486	0.485	0.484	0.483	0.482
3	0.736	0.735	0.733	0.732	0.730	0.729	0.727	0.726	0.724	0.723
4	0.982	0.980	0.978	0.976	0.974	0.972	0.970	0.968	0.966	0.964
5	1.227	1.225	1.222	1.220	1.217	1.215	1.212	1.210	1.207	1.205
6	1.473	1.470	1.467	1.464	1.461	1.458	1.455	1.452	1.449	1.446
7	1.718	1.714	1.711	1.708	1.704	1.701	1.697	1.694	1.690	1.687
8	1.963	1.959	1.955	1.951	1.948	1.944	1.940	1.936	1.932	1.928
9	2.209	2.204	2.200	2.195	2.191	2.186	2.182	2.178	2.173	2.169
10	2.454	2.449	2.444	2.439	2.434	2.429	2.424	2.420	2.415	2.410

84—Continued.

Saccharo- metric Degrees	Density of Juice in Degrees, Brix.									
	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5		
1	0.240	0.240	0.239	0.239	0.238	0.238	0.237	0.237		
2	0.481	0.480	0.479	0.478	0.477	0.476	0.475	0.474		
3	0.721	0.720	0.718	0.717	0.715	0.714	0.712	0.711		
4	0.962	0.960	0.958	0.956	0.954	0.952	0.950	0.948		
5	1.202	1.200	1.197	1.195	1.192	1.190	1.187	1.185		
6	1.443	1.440	1.437	1.434	1.431	1.428	1.425	1.422		
7	1.683	1.680	1.676	1.673	1.669	1.666	1.662	1.659		
8	1.924	1.920	1.916	1.912	1.908	1.904	1.900	1.896		
9	2.164	2.160	2.155	2.151	2.146	2.142	2.137	2.133		
10	2.405	2.400	2.395	2.390	2.385	2.380	2.375	2.370		

85. TABLE SHOWING THE DEGREES BEAUMÉ, BRIX, AND THE SPECIFIC GRAVITY OF SUGAR SOLUTIONS, THE WEIGHTS OF ONE CUBIC FOOT AND ONE GALLON, TOGETHER WITH THE WEIGHT OF THE SOLID MATTER CONTAINED THEREIN.

Degree Beau- mé.	Degree Brix. Per cent. of Solid Matter.	Weight of 1 Cubic Ft. Lbs.	Solid Matter in 1 Cu. Ft. Lbs.	Weight of 1 Gallon. Lbs.	Solid Matter in 1 Gallon. Lbs.	Specific gravity.
0.5	0.9	62.60	0.56	8.37	0.07	1.0035
1.0	1.8	62.83	1.13	8.40	0.15	1.0070
1.5	2.7	63.05	1.70	8.43	0.23	1.0105
2.0	3.6	63.27	2.24	8.46	0.30	1.0141
2.5	4.5	63.50	2.86	8.49	0.38	1.0177
3.0	5.5	63.73	3.50	8.52	0.47	1.0217
3.5	6.3	63.95	4.04	8.55	0.54	1.0249
4.0	7.2	64.17	4.63	8.58	0.62	1.0286
4.5	8.1	64.40	5.21	8.61	0.70	1.0323
5.0	9.0	64.62	5.83	8.64	0.78	1.0360
5.5	9.9	64.85	6.43	8.67	0.86	1.0397
6.0	10.8	65.07	7.03	8.70	0.94	1.0435
6.5	11.7	65.30	7.63	8.73	1.02	1.0472
7.0	12.6	65.52	8.24	8.76	1.10	1.0510
7.5	13.5	65.82	8.90	8.80	1.19	1.0549
8.0	14.4	66.05	9.50	8.83	1.27	1.0587
8.5	15.4	66.27	10.17	8.86	1.36	1.0630
9.0	16.3	66.50	10.84	8.89	1.45	1.0670
9.5	17.1	66.72	11.41	8.92	1.53	1.0704
10.0	18.0	67.02	12.06	8.96	1.63	1.0744
10.5	18.9	67.24	12.71	8.99	1.70	1.0784
11.0	19.9	67.46	13.37	9.02	1.79	1.0829
11.5	20.8	67.77	14.10	9.06	1.88	1.0869
12.0	21.7	68.07	14.77	9.10	1.97	1.0909
12.5	22.6	68.29	15.42	9.13	2.06	1.0950
13.0	23.5	68.52	16.10	9.16	2.15	1.0991
13.5	24.4	68.81	16.79	9.20	2.25	1.1033

85—Continued.

Degree Beau- mé.	Degree Brix. Per cent. of Solid Matter.	Weight of 1 Cubic Ft. Lbs.	Solid Matter in 1 Cu. Ft. Lbs.	Weight of 1 Gallon. Lbs.	Solid Matter in 1 Gallon. Lbs.	Specific gravity.
14.0	25.3	69.04	17.47	9.23	2.34	1.1074
14.5	26.2	69.31	18.17	9.27	2.42	1.1116
15.0	27.2	69.64	18.94	9.31	2.53	1.1163
15.5	28.1	69.86	19.63	9.34	2.62	1.1206
16.0	29.0	70.16	20.34	9.38	2.72	1.1249
16.5	29.9	70.39	21.05	9.41	2.81	1.1292
17.0	30.8	70.68	21.77	9.45	2.91	1.1335
17.5	31.8	70.99	22.57	9.49	3.01	1.1384
18.0	32.7	71.28	23.30	9.53	3.11	1.1427
18.5	33.6	71.51	24.03	9.56	3.21	1.1472
19.0	34.6	71.88	24.87	9.61	3.32	1.1521
19.5	35.5	72.11	25.60	9.64	3.42	1.1565
20.0	36.4	72.40	26.35	9.68	3.51	1.1611
20.5	37.4	72.70	27.19	9.72	3.62	1.1662
21.0	38.3	73.01	27.96	9.76	3.74	1.1707
21.5	39.2	73.30	28.73	9.80	3.84	1.1753
22.0	40.1	73.60	29.51	9.84	3.95	1.1799
22.5	41.1	73.90	30.37	9.88	4.07	1.1851
23.0	42.1	74.20	31.23	9.92	4.16	1.1903
23.5	43.0	74.50	32.03	9.96	4.28	1.1950
24.0	44.0	74.87	32.94	10.01	4.40	1.2003
24.5	44.9	75.17	33.75	10.05	4.51	1.2051
25.0	45.9	75.47	34.64	10.09	4.62	1.2104
25.5	46.8	75.77	35.46	10.13	4.74	1.2153
26.0	47.7	76.07	36.28	10.17	4.85	1.2202
26.5	48.7	76.44	37.23	10.22	4.97	1.2256
27.0	49.6	76.74	38.06	10.26	5.09	1.2306
27.5	50.6	77.11	39.02	10.31	5.22	1.2361
28.0	51.5	77.42	39.87	10.35	5.33	1.2411
28.5	52.5	77.72	40.80	10.39	5.45	1.2467
29.0	53.5	78.09	41.78	10.44	5.58	1.2523
29.5	54.4	78.39	42.64	10.48	5.69	1.2574
30.0	55.4	78.76	43.63	10.53	5.83	1.2 31
30.5	56.4	79.06	44.59	10.57	5.95	1.2689
31.0	57.3	79.44	45.52	10.62	6.09	1.2741
31.5	58.3	79.81	46.53	10.67	6.22	1.2799
32.0	59.3	80.18	47.55	10.72	6.36	1.2859
32.5	60.3	80.56	48.50	10.77	6.49	1.2911
33.0	61.2	80.93	49.53	10.82	6.62	1.2970
33.5	62.2	81.31	50.56	10.87	6.76	1.3030
34.0	63.1	81.69	51.55	10.92	6.90	1.3084
34.5	64.1	81.98	52.55	10.96	7.03	1.3154
35.0	65.2	82.43	53.74	11.02	7.18	1.3211
35.5	66.2	82.80	54.81	11.07	7.33	1.3272
36.0	67.2	83.16	55.88	11.12	7.47	1.3333
36.5	68.2	83.54	56.97	11.17	7.62	1.3395
37.0	69.2	83.93	58.06	11.22	7.76	1.3458
37.5	70.2	84.29	59.17	11.27	7.91	1.3521
38.0	71.2	84.74	60.33	11.33	8.07	1.3585
38.5	72.2	85.12	61.46	11.38	8.21	1.3649

85—Continued.

Degree Beaumé.	Degree Brix. Per cent. of Solid Matter.	Weight of 1 Cubic Ft. Lbs.	Solid Matter in 1 Cu. Ft. Lbs.	Weight of 1 Gallon. Lbs.	Solid Matter in 1 Gallon. Lbs.	Specific gravity.
39.0	73.2	85.56	62.63	11.44	8.37	1.3714
39.5	74.2	85.94	63.77	11.49	8.52	1.3780
40.0	75.3	86.24	64.94	11.55	8.67	1.3846
40.5	76.3	86.76	66.19	11.60	8.85	1.3913
41.0	77.3	87.21	67.41	11.66	9.01	1.3981
41.5	78.3	87.65	68.63	11.72	9.18	1.4049
42.0	79.4	88.05	69.91	11.77	9.34	1.4118
42.5	80.4	88.49	71.15	11.83	9.51	1.4187
43.0	81.5	88.99	72.48	11.90	9.69	1.4267
43.5	82.5	89.39	73.75	11.95	9.86	1.4328
44.0	83.6	89.83	75.10	12.01	10.04	1.4400
44.5	84.6	90.28	76.37	12.07	10.21	1.4472
45.0	85.7	90.78	77.75	12.13	10.39	1.4545

86. TABLE OF FACTORS FOR CALCULATING THE PERCENTAGE OF INVERT SUGAR FROM THE AMOUNT OF COPPER FOUND.

Ratio of Cane Sugar and Invert-sugar C:I	mgr Invert-sugar.								
	245	225	200	175	150	125	100	75	50
O : X	57.4	56.2	55.7	55.1	54.1	53.6	53.1	52.6	52.1
R<90:I>10	56.8	55.7	55.1	54.1	53.6	53.1	52.6	52.1	51.6
90:10	56.2	55.1	54.1	53.6	53.1	52.6	52.1	51.6	51.2
91:9	56.2	55.1	54.1	53.6	53.6	53.1	51.6	51.2	50.7
92:8	56.2	54.6	53.6	53.1	52.1	51.6	51.2	50.7	50.3
93:7	55.7	54.1	53.6	53.1	52.1	51.2	50.7	50.3	49.8
94:6	55.7	54.1	53.1	52.6	51.6	50.7	50.3	49.8	49.9
95:5	55.7	53.6	52.6	52.1	51.2	50.8	49.4	48.9	48.5
96:4	....	....	52.1	51.2	50.7	49.8	48.9	47.7	46.9
97:3	....	....	50.7	50.3	49.8	48.9	47.7	46.2	45.1
98:2	....	....	49.9	48.9	48.5	47.8	45.8	43.3	40.0
99:1	....	....	47.7	47.3	46.5	45.1	43.8	41.2	38.1

Factors = F.

P = Amount of substance analyzed. $Z = \frac{Cu}{2}$ = Approximate amount of invert sugar.

$Y = \frac{Cu \times 100}{2p}$ Approximate percentage of invert sugar.

$C = \frac{100 \times \text{Polarization}}{\text{Polarization} + y}$ = Number of the ratio of the cane sugar.

$I = 100 - C$ = Number of the ratio of the invert sugar.

$\frac{Cu}{p} \times F$ = Correct percentage of invert sugar.

III. FERTILIZERS.

87. COMPOSITION OF DIFFERENT CROPS.

	Albumin- oids, per cent.	Fat, per cent.	Soluble Carbo- hydrates, per cent.	Woody Fibre, per cent.	Ash, per cent.	Water, per cent.
Meadow grass.....	3.5	0.8	9.2	4.5	2.0	80.0
Meadow hay.....	9.1	3.0	43.9	32.0	7.0	5.0
Green clover ..	3.3	0.7	7.0	4.5	1.5	83.0
Lucerne hay.....	10.6	2.3	33.5	28.5	8.4	16.7
Corn.....	10.4	5.1	68.5	8.0	1.6	11.4
Oats.....	12.9	6.0	53.8	10.8	3.5	13.0
Wheat grain.....	11.3	1.5	68.1	3.0	1.7	14.4
Wheat straw.....	3.5	1.8	30.3	46.2	4.6	13.6
Wheat bran.....	14.7	4.3	49.8	13.6	5.7	11.9
Barley.....	10.6	2.0	63.7	7.1	2.6	14.0
Rye.....	9.0	3.0	63.0	8.0	1.0	16.0
Bean seed.....	26.2	2.0	44.7	10.2	3.8	13.1
Bean straw.....	6.4	1.6	36.3	36.0	3.9	15.8
Peas.....	22.4	2.0	52.5	6.4	2.4	14.3
Sugar cane.....	0.6	0.3	18.0	9.6	0.5	71.0
Turnips.....	1.1	0.2	5.3	1.0	0.7	91.7
Potatoes.....	2.2	0.2	21.4	1.0	1.2	74.0
Cabbage.....	3.3	0.3	5.1	1.0	1.3	89.0
Coffee.....	11.8	12.2	22.4	38.1	5.3	10.2

88. CONSTITUTION OF PLANT ASHES.

AVERAGE AMOUNT OF ASH-CONSTITUENTS IN 1000 PARTS OF PLANT-
DRY SUBSTANCE.

	Sulfuric Acid.	Phosphoric Acid.	Silicic Acid.	Chlorin.	Potash.	Soda.	Lime.	Magnesia.	Iron Oxid.	Total Ash.
Meadow hay.....	2.8	4.8	16.3	4.4	15.4	2.7	10.1	3.8	0.8	60.2
Corn plant in time of blooming.....	2.2	6.5	8.7	4.6	21.6	2.7	8.1	6.9	1.6	60.0
Winter wheat plant..	2.8	7.2	41.2	7.5	33.8	1.8	4.8	1.4	0.8	97.5
Red clover, in blossom	2.1	6.7	1.6	2.7	32.0	1.4	24.1	7.4	0.7	68.3
Lucerne.....	4.4	6.6	4.5	2.6	18.3	1.5	31.5	3.9	1.0	74.6
Vetch.....	3.4	12.8	5.9	3.7	33.9	6.8	37.4	6.4	1.0	100.5
Winter wheat..	0.1	9.3	0.4	0.04	6.1	0.4	0.7	2.4	0.3	19.7
Winter rye.....	0.2	9.8	0.4	0.1	6.6	0.4	0.6	2.4	0.3	20.9
Summer barley.....	0.4	0.9	7.2	0.2	5.2	0.7	0.7	2.2	0.3	26.0
Oats.....	0.4	7.2	13.9	0.2	5.1	0.7	1.2	2.2	0.2	31.4
Corn.....	0.2	6.8	0.3	0.2	4.2	0.3	0.3	2.3	0.2	15.1
Buckwheat..	0.3	6.7	0.03	0.3	3.2	0.8	0.6	1.7	0.2	13.7
Peas.....	1.0	10.0	0.2	0.4	11.4	0.3	1.4	2.2	0.2	27.3
Garden bean.....	1.3	11.4	0.2	0.3	14.2	0.5	2.2	2.5	0.1	32.2
Red clover.....	1.1	17.1	0.6	0.6	15.9	0.4	2.9	5.8	0.8	45.0

88—Continued.

		Sulfuric Acid.	Phosphoric Acid.	Silicic Acid.	Chlorin.	Potash.	Soda.	Lime.	Magnesia.	Iron Oxid.	Total Ash.
Apple.....	Whole fruit	0.9	2.0	0.6	..	5.1	3.8	0.6	1.3	0.2	14.4
Pear.....		1.1	3.0	0.3	..	10.8	1.7	1.6	1.0	0.2	19.7
Cherry....		1.1	3.5	2.0	0.3	11.4	0.5	1.6	1.2	0.4	22.0
Potatoes...	Bulb	2.5	6.5	0.8	1.2	22.8	1.0	1.0	1.8	0.5	37.7
Sugar beet..		1.5	4.2	0.7	2.0	21.3	3.9	2.1	2.9	0.4	38.6
Carrots.....		3.8	7.0	1.4	2.9	19.7	12.3	6.4	2.6	0.6	55.8
Potato.....	Leaves	5.4	6.9	6.6	5.0	25.4	1.4	29.1	13.4	4.4	94.2
Sugar beet...		9.1	12.1	5.6	20.2	50.1	25.8	25.8	26.8	1.7	175.8
Carrot.....		10.1	6.0	15.2	12.1	15.2	26.8	44.3	4.7	3.4	135.8
Cabbage.....		20.6	12.2	1.8	10.4	55.1	7.5	27.8	5.3	1.4	139.2
Tobacco leaves.....	Straw	7.1	5.8	16.4	9.6	37.0	6.2	76.6	21.6	5.6	184.1
Tea leaves.....		3.8	7.3	5.4	1.0	13.5	10.6	4.9	3.4	5.1	54.8
Hop plant.....		4.3	8.7	19.0	6.1	23.3	3.2	21.0	7.5	2.3	94.7
Winter wheat..		1.3	2.6	36.3	0.9	7.3	0.7	8.1	1.3	0.3	53.7
Summer rye....	Straw	1.4	3.5	30.4	..	13.0	..	4.8	2.1	..	54.4
Oat.....		1.5	2.2	22.8	3.0	10.4	1.4	4.2	1.9	0.7	47.0
Corn.....		1.5	6.2	13.6	0.8	11.2	7.1	4.7	3.0	0.8	48.7
Fodder vetch..		3.9	3.2	4.3	2.6	7.5	8.2	18.5	4.4	0.8	52.5
Lupine.....		3.6	4.4	2.5	1.6	9.6	3.2	17.7	4.8	2.3	49.6

89. TABLE SHOWING HOW MANY POUNDS OF THE CONSTITUENTS MENTIONED ARE WITHDRAWN PER ACRE BY AN AVERAGE CROP.

	Potash (Kall). K ₂ O	Phosphoric Acid. P ₂ O ₅	Nitrogen. N.		Potash (Kall). K ₂ O	Phosphoric Acid. P ₂ O ₅	Nitrogen. N.
Wheat.....	58	45	111	Clover, green....	154	46	171
Rye.....	76	44	87	Lucerne.....	181	65	289
Barley.....	62	35	78	Clover.....	58	29	89
Oats.....	96	35	89	Red clover.....	57	17	95
Corn.....	174	69	146	Esparsette.....	103	36	239
Rice.....	45	24	39	Seradella.....	196	57	128
Sorghum.....	71	68	129	Vetch.....	118	35	149
Buckwheat.....	17	40	63	Rape.....	124	79	154
Pea.....	69	39	153	Poppy.....	92	30	87
Horse pea.....	169	64	254	Hemp.....	54	34	..
Soja bean.....	37	62	297	Cotton.....	35	32	110
Lupine, yellow....	80	37	155	Hops.....	127	54	200
Lupine green.....	63	46	219	Tobacco.....	148	32	127
Potatoes.....	192	55	119	Sugar cane.....	107	37	518
Sugar beet.....	2.0	44	95	Sorghum.....	561	90	446
Cattle turnips....	426	74	187	White cabbage....	514	125	213
Carrots.....	190	65	166	Cauliflower.....	265	76	202
Meadow hay.....	201	53	166	Lettuce.....	72	17	41
Corn, fodder, green	236	66	122	Cucumbers.....	193	94	142
Clover.....	29	18	37	Onions.....	96	49	96

90. POTASH REMOVED FROM THE SOIL BY THE CROPS OF 1887 IN THE UNITED STATES, AS REPORTED BY THE U. S. DEPARTMENT OF AGRICULTURE.

1,456,160,000 bushels of corn,	removed 189,290 tons of potash (K_2O).
456,320,000 " wheat,	" 85,696 "
659,618,000 " oats,	" 54,331 "
20,693,000 " rye,	" 2,860 "
56,812,000 " barley,	" 8,431 "
10 884,000 " buckwheat,	" 618 "
134,108,000 " potatoes,	" 10,045 "
386,240,000 pounds of tobacco,	" 6,949 "
41,454,000 tons of hay,	" 1,112,011 "
7,020,209 bales of cotton,	" 6,673 "

In all, 1,476,904 tons of potash.

91. COMPOSITION OF FERTILIZER MATERIAL.

	Moisture.	Nitrogen.	Potash.	Total Phosphoric Acid.	Available Phosphoric Acid.
South Carolina Rock Phosphate, Land.....	1.5- 2.0	.....	.....	26.5-28.0	.....
South Carolina Rock Phosphate, River.....	1.5- 2.0	.....	.....	26.0-27.0	.....
Florida Rock Phosphate, Land and River Pebble, kiln-dried.....	2.0- 2.5	.....	.....	24.5-29.5	.....
Florida Rock Phosphate, Hard Rock.....	1.0- 2.0	.....	.....	31.5-37.5	.....
Florida Rock Phosphate, Soft Rock.....	1.0- 2.0	.....	.....	28.0-34.0	.....
Navassa Phosphate.....	5.0- 7.0	.....	.....	31.0-34.5	.....
Redonda Phosphate...	1.0- 3.0	.....	.....	45.0-50.0	.....
Spanish Coprolites.....	1.0- 3.0	.....	.....	30.0-32.0	.....
Belgian Phosphates.....	1.0	.....	.....	.....	.....
Canadian Apatite.....	1.0- 2.0	.....	.....	33.0-38.0	.....
Caribbean Sea Phosphatic Guano.....	7.3	.....	.....	26.8	.....
Bat Guano from Texas, undried.....	20.0	8.6	1.3	6.4	.....
Baker Island Guano.....	5.0-20.0	0.3- 0.7	.....	30.0-40.0	.....
Ichaboe Guano.....	20.0-25.0	5.5-10.5	.....	5.0-10.0	.....
Dried Blood (Soft Red, Eastern).....	12.5	10.5	.....	1.9	.....

91—Continued.

	Moisture.	Nitrogen.	Potash.	Total Phosphoric Acid.	Available Phosphoric Acid.
Dried Blood (High Grade, Western).....	10.0-15.0	12.0-13.5	.....	.....	.....
Azotine (Beef).....	3.5	10.5	.....	2.0-5.0	.....
(Pork).....	3.5	12.0	.....	1.0-8.0	.....
Ammonite.....	1.0-2.0	11.5	.....	1.0-8.0	.....
Ammonium Sulfate (Brown).....	8.0-6.0	18.0-19.0	.....	.....	.....
Ammonium Sulfate (White).....	2.0-2.5	20.25	.....	.....	.....
Nitrate of Soda.....	2.0	16.0	.....	.....	.....
Hoof Meal.....	2.0	14.0-14.5	.....	.....	.....
South American Meat Meal.....	5.0-7.0	11.0	.....	2.5-8.0	.....
Tankage.....	12.5	6.7	.....	11.8	.....
mixed with blood.....	8.0-10.0	7.5-8.5	.....	8.0-10.0	.....
Garbage Tankage.....	2.0-3.0	2.5-6.0	2.0-3.5	1.5-2.5	.....
Bone Tankage.....	5.0	5.0-6.0	.....	15.0-17.0	.....
Ground Bone (raw).....	7.5	4.1	.....	23.5	.....
" (steamed).....	.....	2.5-4.0	.....	20.0-24.0	.....
Bone Black (Spent, from Sugar Refineries).....	2.0-3.0	.....	.....	32.5-37.0	.....
Bone Black (Spent, from Oil Refineries).....	2.0-3.0	.....	.....	25.5-29.0	.....
Fish Scrap (platform-dried).....	Maximum 12.0	10.0-11.0	.....	5.0-7.0	.....
Wet Fish.....	40.0-45.0	5.0-6.0	.....	5.0-6.5	.....
Wet Acidulated Fish.....	40.0-45.0	5.0-5.5	.....	4.5-6.0	.....
Thomas' Phosphate Powder.....	.....	.....	.....	17.0-20.0	.....
Acid Phosphate.....	12.0-18.0	.....	.....	.....	5.5-7.5
Dissolved Bone Black.....	10.0-18.0	.....	.....	.....	7.0-8.5
Double Superphosphate.....	.....	.....	.....	.....	45.0
Phosphate of Ammonia.....	.....	12.0	.....	.....	21.0
Phosphate of Potash.....	.....	.....	26.0	.....	40.0
Tobacco Stems.....	10.0	2.3	6.4	0.6	.....
Cotton Seed Meal.....	7.0	6.5-7.0	1.5	2.0	.....
Cotton Seed Hull Ashes.....	.....	.....	22.10	8.4	.....

92. COMPOSITION OF THE RAW PRODUCTS AND MANUFACTURED POTASH SALTS OF THE GERMAN KALI WORKS.

(COPIED FROM THE OFFICIAL PAMPHLET OF THE G. K. W.)

A.—NATURAL PRODUCTS.										
	Potassium Sulfate.	Potassium Chloride.	Magnesium sulfate.	Magnesium Chloride.	Sodium Chloride.	Calcium Sulfate.	Insoluble substances.	Water.	Total Potash.	Salts absorbing and fixing ammonia.
Kainit.....	21.3	2.0	14.5	12.4	84.6	1.7	0.8	12.7	12.8	28.6
Carnallit.....	....	15.5	12.1	21.5	22.4	1.9	0.5	26.1	9.8	35.5
Kieserit.....	....	11.8	21.5	17.2	26.7	0.8	1.3	20.7	7.5	38.5
Sylvinit {	7.1	24.7	5.8	4.0	46.2	1.9	1.9	8.4	19.4	11.7
	17.2	11.1	11.8	8.1	38.2	3.6	0.3	9.7	16.3	23.5
	16.3	14.0	11.8	9.3	34.9	3.6	1.8	8.3	17.6	24.7
B.—CONCENTRATED PRODUCTS.										
a. Potassium Sulfates.										
1. Potassium sulfate, high grade, min. 98%.....	97.2	0.3	0.7	0.4	0.2	0.3	0.2	0.7	52.7	....
2. Potassium sulfate, high grade, min. 90%.....	90.6	1.6	2.7	1.0	1.2	0.4	0.3	2.2	49.9	....
3. Potassium and magnesium sulfate (double manure salt).....	50.4	....	34.0	....	2.5	0.9	0.6	11.6	27.2	34.9
4. Calcined Kieserit.....	....	....	65.8	....	0.9	6.5	15.7	11.1	....	72.3
b. Potassium Murriates.										
Potassium chloride, { 90 to 95%.....	....	91.7	0.2	0.2	7.1	....	0.2	0.6	57.9	....
{ 80 to 85%.....	....	83.5	0.4	0.3	14.5	....	0.2	1.1	52.7	....
{ 70 to 75%.....	1.7	72.5	0.8	0.6	21.2	2.2	0.5	2.5	46.7	....
Calcined manure salt, high grade.....	....	44.5	22.5	4.6	12.4	2.9	5.3	7.8	28.1	30.0
Calcined manure salt, low grade.....	....	25.6	31.1	6.3	10.3	3.5	10.6	12.6	16.2	40.9

**93. NUMBER OF POUNDS REQUIRED OF THE VARIOUS POTASH SALTS
TO EQUAL 2,000 LBS. OF KAINIT.**

	Quantity Equivalent in Potash to 2,000 lbs. of Kainit.	Contain- ing Actual Potash.	Containing lbs. of Val- uable Filler to each 248 lbs. of Potash.
Kainit, containing			
23% Potassium Sulfate.....	2,000 lbs.	248 lbs.	1,752 lbs.
Sylvinit, containing			
30% Potassium Sulfate.....	1,540 "	248 "	1,292 "
Double Manure Salt, containing			
48% Potassium Sulfate.....	961 "	248 "	713 "
Potassium Sulfate, containing			
90% Potassium Sulfate.....	512 "	248 "	264 "
Potassium Muriate, containing			
80% Potassium Chlorid.....	492 "	248 "	244 "

94. APPLICATION OF FERTILIZERS.

MOST FAVORABLE SOIL.	BEST COMPOSITION OF ARTIFICIAL MANURE TO BE APPLIED PER ACRE.	
TOBACCO. Light, pervious soil, rich in humus.	In the temperate zone:	In the tropical zone:
	180 lbs. Potash sulf.	180 lbs. Potash sulf. 48%
	180 " Thomas slag 15 —17%.	45 " High grade su- per phosph.
	180 " Soda nitrate.	40%.
	—	135 " Soda nitrate.
	540 lbs. per year and compost, or about	360 lbs. per year;
	9,000 lbs. stable manure;	Or,
	Or,	75 lbs. Potash phosph.
	50 lbs. Potash phosph.	140 " Potash sulf.
	150 " Potash sulf.	180 " Soda nitrate.
	180 " Soda nitrate.	—
	380 lbs. per year.	395 lbs. per year.
COFFEE. Deep clay soil, rich in humus.	585 lbs. Thomas slag 16%.	220 lbs. Potash phos- phate.
	225 " Potash magnesia sulf.	90 " Soda nitrate.
	90 " Soda nitrate.	—
	900 lbs. per year;	310 lbs. per year:
	Or, if lime was applied	previously:
	405 lbs. Super phosph. 16%	150 lbs. Potash phosph.
	225 " Potash magnesia sulf. 26%.	100 " Potash magne- sia sulf.
	90 " Soda nitrate.	90 " Soda nitrate.
	730 lbs. per year.	340 lbs. per year,

94—Continued.

MOST FAVORABLE SOIL.	BEST COMPOSITION OF ARTIFICIAL MANURE TO BE APPLIED PER ACRE.	
COCA. Clay soil, rather dry and sandy.	180 lbs. Potash sulf. or 155 potash chlorid. 45 " High grade super phosphate, 40%. 135 " Soda nitrate. 360 lbs. per year;	45 lbs. Potash phosphate. 160 " Potash sulf. 135 " Soda nitrate. 340 lbs. per year.
CACAO. Deep soil, rich in humus and lime.	Soils poor in lime must be manured every fifth year with 1,800 to 2,700 lbs. of lime, or 9,000 to 18,000 lbs. of marl per acre. 360 lbs. Super phosphate, 16%. 360 lbs. Kainit or 85 lbs. potash chlorid. 720 lbs. per year. 100 lbs. Potash phosphate. 150 " Kainit. 250 lbs. per year.	
SUGAR CANE. Deep soil, not too heavy, but rich in lime. In sour soils the cane produces but little sugar. Chlorids in the soil are also injurious. They may be partly removed by raising a number of green manure crops.	In periods of 8 to 10 years, 1,800 to 3,600 lbs. of caustic lime. Bagasse ashes according to facilities at command. Eventually 150 to 300 lbs. potash phosphate.	
SORGHUM. Deep soil, not too poor in lime. In the tropics the plant thrives well in dry soil, on account of its deep growing roots.	If planted for the production of sugar: 270 lbs. Super phosphate, 16% 90 " Potash sulf. or 80 lbs. potash chlorid. 90 " Soda nitrate. 450 lbs. per year. If planted for the harvest of grain or green fodder: 270 lbs. Super phosphate, 16%. 270 " Kainit or 65 lbs. potash chlorid. 180 " Soda nitrate. 720 lbs. per year.	
CORN. Deep, and not too heavy, loamy soil; or sandy soil if rich in humus and not too dry.	If planted for the harvest of grain: 270 lbs. Super phosphate, 16%. 270 " Kainit or 65 lbs. potash chlorid. 180 " Soda nitrate. 720 lbs. per year. If planted for the harvest of fodder, nitrate of soda must be omitted. Rich soils must be manured with lime or marl.	

94—Continued.

MOST FAVORABLE SOIL.	BEST COMPOSITION OF ARTIFICIAL MANURE TO BE APPLIED PER ACRE.
RICE. A.—WATER RICE. Heavy, not pervious soil. B.—MOUNTAIN RICE. Light and sandy soil.	90 lbs. Thomas slag. 180 " Kalnit or 45 Potash chlorid. 270 " Ground bone. 540 lbs. per year. 270 lbs. Super phosphate 16%. 360 " Kalnit or 85 Potash chlorid. 90 " Soda nitrate. 720 lbs. per year.
PEANUTS. (Earth Nuts). Light and sandy soil.	Nitrogen manure not required. If the soil is not rich in lime 1,800 to 2,700 lbs. of lime should be used. 450 lbs. Kalnit or 105 Potash chlorid. 270 " Thomas slag 16%. 720 lbs. per year.
BLACK BEAN. All, except very heavy soils.	No nitrogen manure required. 450 lbs. Kalnit or 105 Potash chlorid. 270 " Super phosphate 16%. 720 lbs. per year.
ORANGE AND LEMON. Pervious, deep soil, rich in lime and not marshy.	Fresh stable manure must not be applied. The use of good compost is advisable. For soils containing little lime, manuring with lime is necessary. 270 lbs. Kalnit or 65 Potash chlorid. 270 " Super phosphate 16%. 540 lbs. year. If the growth of the trees is poor 90 lbs. of Soda nitrate will prove advantageous.
BANANA. Moist, deep and pervious soil, rich in humus.	540 lbs. Kalnit. 75 lbs. Potash phosph. 180 " Super phosph. 400 " Kalnit. 720 lbs. per year. 475 lbs. per year.
PINE APPLE. (Ananas.) Medium, heavy soil, containing potash, lime and humus in sufficient quantity.	Each plant is manured with a mixture of 1 part Potash sulfate. 8 parts Peruvian Guano. Or, 1 part Potash phosphate. 1 part Ammonia phosphate.

94—Continued.

MOST FAVORABLE SOIL.	BEST COMPOSITION OF ARTIFICIAL MANURE TO BE APPLIED PER ACRE.
SESAMUM. Soil rich in lime and humus.	180 lbs. Super phosph. 16%. 75 lbs. Potash phosphate. 180 " Kainit or 45 Pot-ash chlorid. 50 " Kainit. 180 " Soda nitrate. 180 " Soda nitrate. 540 lbs. per year. 405 lbs. per year.
CASTOR. (Ricinus). Soil rich in humus.	The use of good compost is to be recommended. 180 lbs. Super phosph. 16%. 75 lbs. Potash phosphate. 180 " Kainit or 45 Pot-ash chlorid. 50 " Kainit. 180 " Soda nitrate. 180 " Soda nitrate. 540 lbs. per year. 305 lbs. per year.
OLIVE. Light, dry soil, containing sufficient lime.	Lime to be applied if not present in the soil in sufficient quantity. Cakes from oil presses serve as a very good compost. 270 lbs. Kainit or 65 Potash chlorid. 180 " Super phosphate 16%. 450 lbs. per year.
COCOA AND OIL PALM. Moist soil, rich in humus. Under-ground water is injurious.	In dry soil the plant is to be watered. Compost and wood ashes are generally used. Kainit and Super phosphate are to be recommended.
COTTON. Deep, sandy and loamy soil, rich in lime.	Heavy soils require manuring with lime and compost or stable manure. 360 lbs. Kainit. 150 lbs. Potash phosphate. 360 " Super phosph. 16%. 50 " Kainit. 180 " Soda nitrate. 180 " Soda nitrate. 900 lbs. per year. 380 lbs. per year.
RAMIE. Light soil, rich in humus.	Needs abundant fertilizing. Besides compost and stable manure use 540 lbs. Kainit. 180 " Super phosphate 16%. 180 " Soda nitrate. 900 lbs. per year.

94—Continued.

MOST FAVORABLE SOIL.	BEST COMPOSITION OF ARTIFICIAL MANURE TO BE APPLIED PER ACRE.
JUTE. Light soil, rich in humus.	Needs abundant fertilizing. 540 lbs. Kalnit. 190 " Super phosphate 16% 180 " Soda nitrate. 900 lbs. per year.
PEAS AND BEANS. Soil rich in humus.	230 lbs. Potash phosphate. 80 " Potash chlorid. 310 lbs. per year.
WHITE CABBAGE, SAVOY, CAULIFLOWER, KOHLRABI and other varieties of cabbage.	205 lbs. Potash phosphate. 115 " Potash chlorid. 320 lbs. per year.
CARROTS, TURNIPS, BLACK RADISH, RADISH and similar plants.	205 lbs. Potash phosphate. 115 " Potash chlorid. 133 " Soda nitrate. 453 lbs. per year.
CUCUMBERS AND ONIONS.	205 lbs. Potash phosphate. 71 " Potash chlorid. 276 lbs. per year. Before sowing the plants 90 lbs. of Soda nitrate is harrowed in the soil.
STRAWBERRIES.	133 lbs. Potash phosphate. 89 " Ammonium sulfate.
ASPARAGUS. Light soil.	205 lbs. Potash phosphate. 71 " Potash chlorid.

95. COMPARISON OF SURFACE MEASURES.

- 1 square mile = 640 acres = 259 hectares.
- 1 acre = 43,560 square feet = 0.4047 hectare.
- 1 hectare = 2.4711 acres.
- 1 Prussian morgen = 0.6309 acre.
- 1 Saxon acker = 1.3676 acres.
- 1 Saxon morgen = 0.6838 acre.
- 1 kilo per 1 hectare is equal to 0.8903 lbs. per 1 acre
- 1 zollpfund per 1 Prussian morgen is equal to 1.7435 lbs. per 1 acre.
- 1 zollpfund per 1 Saxon morgen is equal to 1.6066 lbs. per 1 acre.

96. TABLE FOR CALCULATING ANALYTICAL RESULTS.

Substances Given in Analysis.	To Obtain Corresponding Percentage in Substances Sought.	Multiply By.
Phosphoric acid.....	Bone phosphate.....	2.183
Bone phosphate.....	Phosphoric acid.....	0.458
Nitrogen.....	Ammonia.....	1.215
Ammonia.....	Nitrogen.....	0.823
Potash.....	Potassium chlorid.....	1.583
Potash.....	Potassium sulfate.....	1.850
Potassium chlorid.....	Potash.....	0.632
Potassium chlorid.....	Potassium sulfate.....	1.169
Potassium sulfate.....	Potash.....	0.541
Potassium sulfate.....	Potassium chlorid.....	0.856
Carbonic acid.....	Calcium carbonate.....	2.273
Calcium carbonate.....	Carbonic acid.....	0.440
Ammonium sulfate.....	Ammonia.....	0.258
Ammonia.....	Ammonium sulfate.....	3.876
Nitrogen.....	Sodium nitrate.....	6.064
Sodium nitrate.....	Nitrogen.....	0.165

IV. WATER AND STEAM.

97. QUALITY OF WATER FOR DIFFERENT ECONOMICAL AND TECHNICAL PURPOSES.

FEEDING BOILERS.—For this purpose a water should be used which contains very small percentages of carbonate and sulfate of lime. The water must be free of ammonium salts and fatty substances, and should only contain a slight amount of free and half combined carbonic acid, dissolved oxygen and humus.

USE IN BREWERIES.—The water should be free from micro-organisms and organic substances.

USE IN SUGAR HOUSES.—The water should be free from nitrates and from carbonates of alkali, and should contain only small quantities of sulfates.

FOR DYEING, PRINTING AND BLEACHING PURPOSES.—The water must be clear, colorless, and if possible, river water containing only small percentages of lime and magnesium salts, and very small percentages of iron.

FOR PAPER FACTORIES.—The best water for this purpose is a water free from iron salts, which contains only small percentages of carbonate and sulfate of lime and magnesium salts.

FOR GLUE FACTORIES.—The water should contain very small quantities of lime and magnesium salts; only such a water extracts the whole amount of available substances from the raw materials and gives a clear and perfect glue.

98. TECHNICAL CALCULATIONS ON WATER AND STEAM.

1 cubic foot of water weighs 62.4 pounds.
 1 cubic foot = 7 48 gallons.

1. A gallon of fresh water weighs $8\frac{1}{2}$ pounds and contains 231 cubic inches.

2. A cubic foot of water weighs $62\frac{1}{2}$ pounds and contains 1,728 cubic inches, or $7\frac{1}{2}$ gallons.

3. A "miner's inch" of water is approximately equal to a supply of 12 gallons per minute.

4. The friction of water in pipes increases with the square of its velocity.

5. The capacity of pipes increases with the square of their diameter; thus, doubling the diameter increases the capacity four times.

6. To find the area of piston, square the diameter and multiply by 0.7854.

7. In calculating horse power of tubular boilers, 15 square feet of heating surface is equivalent to one nominal horse power.

8. Each nominal horse power of boilers will require about one cubic foot of water per hour.

9. The mean pressure of the atmosphere is usually estimated at 14.7 pounds per square inch, so that with a perfect vacuum it will sustain a column of mercury 29.9 inches, or a column of water 33.9 feet high.

10. To find the capacity of a cylinder in gallons: Multiplying the area in inches by the stroke in inches will give the total number of cubic inches; divide this amount by 231 (which is the cubical contents of a gallon in inches), and the quotient is the capacity in gallons.

11. To find the pressure in pounds per square inch of a gallon of water, multiply the height of the column in feet by 0.434. Approximately each foot elevation is called equal to one-half pound pressure per square inch.

12. To find the diameter of a pump cylinder to move a given quantity of water per minute at a piston travel of 100 feet per minute, divide the number of gallons by 4, then extract the square root and the result will be the diameter of the pump cylinder in inches.

13. To find the horse power required to elevate water to a given height, multiply the total weight of the water in pounds by the height in feet and divide the product by 33,000. An allowance should be made of 25 per cent. for water friction; also about 25 per cent. for loss in steam pipe and cylinder.

14. The area of the steam piston, multiplied by the steam pressure, gives the total amount of pressure exerted. The area of the water piston multiplied by the pressure of water per square inch, gives the resistance. A margin of from 30 to 50 per cent. must be added to move the piston at the required speed.

FRICTION OF WATER IN PIPES.

Friction loss in pounds pressure per square inch, for each 100 feet of length in different size, clean iron pipes, discharging given quantities of water per minute.

Galls. per Minute.	Sizes of pipes, inside diameter.							
	$\frac{3}{4}$ In.	1 In.	$1\frac{1}{4}$ In.	$1\frac{1}{2}$ In.	2 In.	$2\frac{1}{2}$ In.	3 In.	4 In.
5	3 3	0.84	0.31	0.12	....	....	....	....
10	13 0	3.16	1.05	0.47	0.12	....	....	....
15	28 7	6.98	2.38	0.97	....	....	....	....
20	50.4	12.3	4.07	1.66	0.42	....	....	....
25	78.0	19.0	6.40	2.62	....	0.21	0.10	....
30	....	27.5	9.15	3.75	0.91	....	....	....
35	....	37.0	12.4	5.05	....	....	....	....
40	....	48.0	16.1	6.52	1.60	....	....	....
45	....	....	20.2	8.15	....	....	....	....
50	....	....	24.9	10.0	2.44	0.81	0.35	0.09
75	....	....	56.1	22.4	5.32	1.80	0.74	....
100	....	....	....	39.0	9.46	3.20	1.31	0.33
125	....	....	....	....	14.9	4.89	1.99	....
150	....	....	....	....	21.2	7.0	2.85	0.69
175	....	....	....	....	28.1	9.46	3.85	....
200	....	....	....	....	37.5	12.47	5.02	1.22
250	....	....	....	....	....	19.66	7.76	1.89
300	....	....	....	....	....	28.06	11.2	2.66
350	....	....	....	....	....	....	15.2	3.65
400	....	....	....	....	....	....	19.5	4.73
450	....	....	....	....	....	....	25.0	6.01
500	....	....	....	....	....	....	30.8	7.43
Sizes of pipes, inside diameter.								
	6 In.	8 In.	10 In.	12 In.	14 In.	16 In.	18 In.	
100	0.05	....	....	....	....	....	....	
125	....	....	....	....	....	....	....	
150	0.10	....	....	....	....	....	....	
175	....	....	....	....	....	....	....	
200	0.17	....	....	....	....	....	....	
250	0.26	0.07	0.03	0.01	....	....	....	
300	0.37	0.09	0.04	....	....	....	....	
350	0.50	0.12	0.05	0.02	....	....	....	
400	0.65	0.16	0.06	....	....	....	....	
450	0.81	0.20	0.07	0.03	....	....	....	
500	0.96	0.25	0.09	0.04	0.017	0.009	0.005	
750	2.21	0.53	0.18	0.08	....	....	....	
1000	3.88	0.94	0.32	0.13	0.062	0.036	0.020	
1250	....	1.46	0.49	0.20	....	....	....	
1500	....	2.09	0.70	0.29	0.135	0.071	0.040	
1750	....	....	0.95	0.38	....	....	....	
2000	....	....	1.23	0.49	0.234	0.123	0.071	
2250	....	....	....	0.63	....	....	....	
2500	....	....	....	0.77	0.362	0.188	0.107	
3000	....	....	....	1.11	0.515	0.267	0.150	

99.

ANALYSES OF AMERICAN WATERS.

COMPILED BY C. F. CHANDLER FROM THE REPORT OF PROF. J. W. WALLEY, REPORT OF THE NATIONAL BOARD OF HEALTH FOR 1882, WASHINGTON, D. C.—PARTS BY WEIGHT IN ONE MILLION.

Mallet's number.	Character of the Water.	Total solids at 100° C.	Loss on ignition.	Chlorine.	Frankland's combustion process.		Albuminoid ammonia process.		Nitrogen of Naphthyl-amine test.	Nitrogen of Nitrates, Cyan's Mercury method.	Permanganate Process.			Dissolved Oxygen.
					Organic Carbon.	Organic Nitrogen.	Free ammonia.	Albuminoid.			Tidy's method, cold.	Kubel's method, boiling.		
													In 1 hr.		In 3 hrs.	In 10 m.
1	Rain, water, iron tank, New Orleans, La.	55	35	1.70	1.75	0.99	0.045	0.145	trace	0.500	1.522	1.964	2.001	5.84
5	Pure spring, Univ. of Virginia.	20	trace	0.75	0.36	0.08	0.020	0.020	none	trace	0.140	0.248	0.632	7.87
20	Public spring, Harrisonburg, Va.	270	20	4.00	1.49	0.52	0.130	0.144	0.184	5.060	0.082	0.226	0.528	6.49
23	Lake Champlain, Burlington, Vt.	70	50	0.70	2.81	0.32	0.035	0.140	none	trace	1.132	1.388	1.525	7.06
19	Lake Michigan, Chicago, Ill.	160	60	2.00	1.40	0.31	0.035	0.060	none	trace	0.264	0.400	1.500	9.08
13	Lake Roland, Baltimore, Md.	110	35	2.33	1.67	0.39	0.010	0.110	trace	0.370	0.520	0.684	1.328	4.25
11	Cochituate, Boston, Mass.	60	10	3.60	7.20	0.66	0.070	0.255	trace	trace	4.008	5.213	7.443	7.66
12	Croton, New York City.	90	20	0.67	3.96	0.62	0.020	0.150	0.018	trace	1.769	2.163	3.433	6.57
44	Hudson River, Peekskill, N. Y.	85	40	4.50	2.97	0.56	0.050	0.125	trace	trace	1.062	1.376	2.287	7.08
47	Crosswicks Crk., Bord't'n, N. J.	80	45	2.33	3.07	0.53	0.035	0.175	0.005	trace	1.699	2.211	2.719	6.67
14	Schuylkill, Philadelphia, Pa.	130	30	6.00	2.19	0.65	0.105	0.210	trace	0.320	1.172	1.436	2.140	6.33
15	Pocomac, Washington, D. C.	165	95	1.10	2.20	0.44	0.050	0.137	trace	0.230	0.864	1.016	1.021	7.54
16	James River, Richmond, Va.	105	30	1.17	1.41	0.33	0.550	0.150	trace	trace	0.512	0.636	1.654	6.41
26	Mississippi River, Rock Isld., Ill.	140	95	1.00	7.79	0.52	0.025	0.360	none	trace	3.340	4.188	6.000	7.46
17	Miss. River, New Orleans, La.	340	50	14.50	6.14	0.76	0.040	0.325	none	0.080	2.398	3.142	5.724	5.33
45	Trinity River, Dallas, Texas.	460	170	13.50	22.10	0.76	0.040	0.370	none	0.470	1.172	1.708	2.534	7.91
49	Oil Creek, Titusville, Pa.	100	50	0.75	3.78	0.33	0.075	0.150	none	none	2.044	2.472	3.746	6.06
21	Driven wells, Titusville, Pa.	200	30	4.00	0.99	0.34	0.030	0.025	0.055	1.130	1.063	1.181	none	7.81
35	Driven well, Asbury Park, N. J.	225	50	06.00	0.94	0.40	0.358	0.058	0.033	8.507	0.262	0.396	0.107	7.81
9	Well, University of Virginia.	40	30	3.75	0.98	0.20	0.015	0.020	trace	1.040	0.216	0.284	0.097	7.57
24	Well, Fairfax Court House, Va.	60	45	2.00	0.68	0.26	0.070	0.070	0.037	1.123	0.278	0.410	none	6.64
42	Well, Ripley, Miss.	70	30	3.35	0.73	0.46	0.140	0.046	trace	trace	0.192	0.328	0.486	6.59
41	Well, Closter, N. J.	115	65	5.00	0.35	0.07	0.025	0.020	none	2.830	0.160	0.192	none	8.48

COMPOSITION OF EUROPEAN WATERS.

100.

Source.	Constituents of Solid Contents ; parts by weight in 1,000,000.														Gaseous contents cc per liter.	
	Total solids contents: ppts. in 1,000,000.														CO ²	O N
Thames, at London B'dge	408.4	82.1	14.3	1.7	..	..	..	..	69.4	32.2	63.6	1.8	..	100.0	27.2	..
Lake of Geneva.....	152.0	36.4	10.5	..	..	..	..	..	48.2	43.2	6.7	1.0	..	6.0	..	..
Rhone, at Lyons.....	184.0	65.9	1.4	..	..	..	..	..	90.0	19.7	..	7.0	..	..	..	..
Loire, at Orleans.....	134.6	19.2	1.7	9.3	..	7.1	5.5	..	41.5	2.3	2.9	40.6	..	..	1.8	..
Garonne, at Toulouse.....	136.7	25.8	0.9	5.8	3.4	..	3.1	3.0	44.8	7.8	1.9	40.1	..	..	17.0	7.9 15.7
Aar, near Berne.....	216.3	66.0	10.0	0.3	..	..	..	..	103.3	33.7	0.3	2.7	..	..	..	..
Aar, near Basle.....	169.4	55.5	4.8	0.6	..	..	..	..	86.2	15.4	1.5	2.1	..	3.3	..	..
Rhine, at Basle.....	126.9	27.9	1.1	..	..	..	1.2	..	44.7	7.2	39.4	5.4	..	..	..	..
Elbe, near Hamburg	114.0	26.0	2.6	2.3	1.5	13.0	..	..	45.4	8.6	0.6	..	3.0	..	..	..
Spree, at Berlin.....	141.4	34.3	7.0	..	..	..	..	..	60.9	13.1	2.0	4.9	..	..	..	..
Danube, near Vienna.....	141.4	34.3	7.0	..	..	..	..	..	60.9	13.1	2.0	4.9	..	..	..	..

COMPOSITION OF EUROPEAN WATERS.																	
Constituents of Solid Contents ; parts by weight in 1,000,000.																	
Source.	Total solids contents: ppts. in 1,000,000.		Ca	Mg	Na	K	Al	Fe	Mn	CO ²	SO ⁴	Cl	SiO ²	NO ³	Organic	CO ²	O N
14 Well, Jacksonville, Fla.....	170	60	28.00	1.47	0.35	0.230	0.095	0.018	4.342	0.467	0.807	1.049	6.99	0.467	0.807	1.049	6.99
40 Well, Port Chester, N. Y.....	200	80	29.00	2.17	1.41	0.025	0.130	0.062	7.038	0.111	0.271	0.485	7.32	0.111	0.271	0.485	7.32
30 Well, Jonesville, Mich.	245	50	7.00	4.11	1.03	0.220	0.150	0.276	3.164	2.880	3.764	4.674	5.45	2.880	3.764	4.674	5.45
25 Well, Andover, Mass.....	360	100	46.60	0.73	0.53	0.010	0.045	none	6.790	0.104	0.104	none	7.18	0.104	0.104	none	7.18
37 Well, Meridian, Miss.....	360	100	56.00	0.67	0.26	0.015	0.070	0.004	8.496	0.132	0.300	0.288	7.21	0.132	0.300	0.288	7.21
28 Well, Wellsville, Ohio.....	320	130	20.03	0.97	0.77	0.070	0.100	trace	6.610	0.586	1.843	1.102	6.89	0.586	1.843	1.102	6.89
38 Well, Lexington, Mich.....	370	20	18.70	3.75	0.73	0.080	0.150	0.011	3.239	1.407	1.843	2.737	6.52	1.407	1.843	2.737	6.52
31 Well, Adamstown, Md.....	400	120	41.50	0.86	1.28	0.140	0.240	0.040	8.740	0.934	1.478	0.586	6.01	0.934	1.478	0.586	6.01
32 Well, City Park, Charlotte, Mich.	430	60	7.50	0.98	0.57	0.080	0.130	0.080	7.060	0.130	0.136	0.639	6.31	0.130	0.136	0.639	6.31
27 Well, Little Rock, Ark.....	610	320	93.00	0.86	6.88	0.190	0.075	0.087	28.403	0.136	0.136	0.639	6.31	0.136	0.136	0.639	6.31
36 Well, Newport, R. I.....	720	170	1.08	1.41	1.51	0.025	0.080	0.009	30.391	0.183	0.383	1.106	7.56	0.183	0.383	1.106	7.56
50 Well, Huntingdon, Pa.....	810	280	106.00	2.03	0.03	0.120	0.086	0.020	15.961	0.430	0.692	0.453	7.09	0.430	0.692	0.453	7.09
35 Well, Union City, Tenn.....	830	330	132.00	1.17	0.98	0.030	0.050	0.000	13.050	0.724	1.076	0.344	6.22	0.724	1.076	0.344	6.22
43 Well, Mount Vernon, Ohio	1160	400	79.00	0.50	0.55	0.150	0.100	none	24.990	0.324	0.404	0.535	7.11	0.324	0.404	0.535	7.11
29 Well, Mount Vernon, Ohio	1170	100	130.00	1.57	0.59	0.300	0.040	0.308	none	0.527	0.927	2.043	5.85	0.527	0.927	2.043	5.85
2 Artesian well, Charleston, S. C.	65	40	1.33	1.27	0.33	0.080	0.155	trace	trace	0.292	0.388	0.973	6.84	0.292	0.388	0.973	6.84
53 Ice, Almy's Pond, Newport, R. I.	65	40	1.33	1.27	0.33	0.080	0.155	trace	trace	0.292	0.388	0.973	6.84	0.292	0.388	0.973	6.84

101. COMPOSITION OF AMERICAN MINERAL WATERS.
PARTS BY WEIGHT IN ONE MILLION.

	Bethesda.	Buffalo Lithia Spring No. 3.	Richfield sulfur spring water.	Saratoga geyser.	Sharon spring water. Red sul- fur spring.
Calcium bicarbon- ate.....	291.61	213.76	396.4	2026.7	153.7
Magnesium bicar- bonate.....	212.22	....	97.4	1414.2	7.0
Sodium bicarbonate	21.52	....	....	846.0	5.9
Potassium bicar- bonate.....	....	418.57	....	....	....
Iron bicarbonate...	0.72	4.18	3.8	12.2	....
Lithium bicarbon- ate.....	....	32.14	....	75.2	....
Strontium bicar- bonate.....	....	....	....	5.6	....
Sodium chlorid....	19.87	70.30	352.1	9625.6	5.6
Potassium chlorid..	....	....	133.4	421.8	....
Magnesium chlorid.	....	....	....	....	12.5
Calcium chlorid....	....	....	....	....	1.1
Sodium iodid....	....	....	....	....	....
Sodium bromid....	....	....	....	37.8	....
Phosphoric com- pounds.....	traces, Na ² HPO ⁴	....	....	4.2	....
Silicious compound	12.69SiO ²	26.76	21.9	1.8	7.7
Sodium sulfate.....	9.29	....	361.2	....	....
Potassium sulfate.	7.78	....	....	....	....
Alumina.....	2.09	....	1.7	....	....
Organic matter.....	33.97	....	....	....	....
Magnesium sulfate.	....	12.64	531.7	....	324.7
Alumina sulfate....	....	129.53	....	....	....
Calcium sulfate....	....	472.39	1091.9	....	1655.0
Barium bicarbon- ate.....	....	25.00	....	28.2	....
Sulphids.....	....	....	100.8 Ca Na	....	15.2
Total solids	611.76	1405.27	3092.7	14,499.3	2188.4
Free H ² S.....	....	61.9	{ free 38.4 cc comb. 27.1 cc }	{ }	{ 445.0 }
p. 1 l. at 0° C 760 mm {	....	....	{ free 24.5 cc comb. 76.2 cc }	{ 1980.0 }	{ 198.0 }
Free CO ².....	....	441.3	....	....	....

102. COMPOSITION OF EUROPEAN MINERAL WATERS.

Source.	Constituents of solid contents; parts by weight in 1,000,000.										
	Parts by weight in 1,000,000. Total.	Ca	Ba	Sr	Mg	Na	K	Li	NH ⁴	Al	Mn
Vichy, France (Puits Carré).....	5160.0	117.1	...	1.7	46.2	1814.0	162.7	...	...	...	2.0
Bilin, Bohemia (Josefsquelle).....	5061.0	159.7	...	0.5	44.5	1896.7	101.4	...	...	...	0.7
Ems, Nassau (Kesselbrunnen).....	2781.2	59.4	0.3	0.6	29.3	1122.9	34.7	...	...	trace	1.6
Teplitz, Bohemia (Steinbad).....	636.2	25.9	...	...	11.0	195.2	0.4	...	...	...	2.1
Spa, Belgium (Pouhon).....	563.0	51.8	...	...	41.7	66.0	4.6	...	...	1.1	23.2
Pfäfers, Switzerland.....	252.4	48.4	...	...	10.3	24.0	0.3	...	...	...	0.3
Carlsbad, Bohemia (Sprudel).....	5435.7	125.0	...	0.5	50.3	1793.0	...	...	...	trace	1.7
Pyrmont, Waldeck.....	2935.0	598.3	...	1.2	119.1	90.4	1.9	0.2	...	trace	30.2
Wiesbaden, Nassau (Kesselbrunnen)	8202.0	363.2	...	...	54.9	2937.4	79.4	...	5.6	trace	2.6
Selters, Nassau.....	3656.0	113.9	0.1	1.4	51.2	1232.9	47.8	trace	...	trace	trace
Apollinaris.....	2552.0	23.6	...	...	126.3	825.8	trace	...	10.0	10.0	10.0
Gaseous contents in c. c. per liter, at 0°C and 760 mm. pressure.											
CO ²	2415.0	196.8	...	...	...	16.7	trace	...	...	...	...
SO ²	2029.9	769.7	...	...	...	3.8	...	...	...	...	...
CO ²	95.2	38.7	0.1	487.0	...	0.2	...	...	...	...	...
CO ²	262.4	48.5	...	...	2.5	1.9	...	...	...	...	...
CO ²	265.1	9.0	...	...	1.8	...	...	...	...	...	...
CO ²	85.9	24.1	...	...	...	...	...	...	...	...	...
CO ²	1028.5	1749.1	1.5	690.2	...	0.4	...	...	...	...	...
CO ²	534.7	1186.1	...	106.4	...	1.8	...	...	...	...	...
CO ²	261.5	63.7	...	4687.4	3	0.4	...	...	...	...	...
CO ²	753.8	28.4	1.5	1988.5	...	...	...	...	...	...	...
CO ²	1062.5	208.0	...	282.8	...	traces	...	...	...	...	...

Constituents of solid contents; parts by weight in 1,000,000.

Source.

Source.	Constituents of solid contents; parts by weight in 1,000,000.										
	CO ²	SO ²	F	Cl	Br	NO ³	PO ⁴	BO ³	SiO ²	AsO ⁴	CO ²
Vichy, France (Puits Carré).....	2415.0	196.8	...	324.8	...	...	16.7	trace	68.0	1	445.0
Bilin, Bohemia (Josefsquelle).....	2029.9	769.7	...	227.9	...	...	3.8	...	46.2	...	305.0
Ems, Nassau (Kesselbrunnen).....	95.2	38.7	0.1	487.0	...	...	0.2	...	53.9	...	98.0
Teplitz, Bohemia (Steinbad).....	262.4	48.5	...	33.5	...	2.5	1.9	...	41.9	...	...
Spa, Belgium (Pouhon).....	265.1	9.0	...	35.5	...	1.8	...	...	60.5	...	744.0
Pfäfers, Switzerland.....	85.9	24.1	...	40.5	...	...	...	...	18.2	...	...
Carlsbad, Bohemia (Sprudel).....	1028.5	1749.1	1.5	690.2	...	0.4	...	...	75.1	...	38.0
Pyrmont, Waldeck.....	534.7	1186.1	...	106.4	...	1.8	...	...	65.5	...	1100.0
Wiesbaden, Nassau (Kesselbrunnen)	261.5	63.7	...	4687.4	3	0.4	...	...	60.4	...	1680.0
Selters, Nassau.....	753.8	28.4	1.5	1988.5	...	...	...	...	39.2	...	197.0
Apollinaris.....	1062.5	208.0	...	282.8	...	traces	...	...	8.0	...	1067.0

Source.	Parts by weight in 1,000,000 Total solid contents	Constituents of solid contents; parts by weight in 1,000,000.						
		Ca	Mg	Na	K	NH ⁴	Al	Fe
Atlantic Ocean, 41° 18' N., 36° 28' W.....	38400.0	556.8	1198.1	11719.7	668.2	....	....	....
Pacific Ocean, 25° 11' S., 93° 24' W., 490 ft. deep.....	35200.0	475.2	1471.4	10232.6	633.6	....	....	....
German Ocean, between Belgium and England.....	32900.0	324.4	1158.2	10205.7	853.6	....	....	....
Baltic.....	17710.0	36.8	611.5	5894.1	....	....	....	....
Mediterranean, off Cette.....	37700.0	444.1	1810.4	11706.2	264.3	....	....	2.8
Black Sea, off southern coast of Crimea.....	1766.1	180.5	662.2	5512.0	97.5	....	....	127.1
Caspian Sea.....	6296.0	191.6	409.8	1444.0	139.7	....	40.1	....
Dead Sea.....	240483.3	9000.0	19883.4	47918.0	6885.1	18	153.4	11.7

Source.	Mn	CO ²	SO ⁴	Cl	Br	PO ⁴	SiO ²	Organic.
Atlantic Ocean, 41° 18' N., 36° 28' W.....			3029.8	20639.7	387.8	....	....	....
Pacific Ocean, 25° 11' S., 93° 24' W., 490 ft. deep.....			2826.6	19821.3	239.4	....	....	....
German Ocean, between Belgium and England.....			2580.2	18167.9	....	trace	16.3	....
Baltic.....			718.9	10866.4	....	....	....	....
Mediterranean, off Cette.....		67.9	2942.8	20526.9	438.5	....	....	....
Black Sea, off southern coast of Crimea.....		247.5	1250.2	9574.5	5.0	....	....	....
Caspian Sea.....		77.3	1337.2	2737.7	....	....	....	....
Dead Sea.....	55.8	....	479.0	154442.0	2176.7	....	....	617.3

Constituents of solid contents; parts by weight in 1,000,000.

V. MINING AND METALLURGY.

104. FUSING POINTS OF METALS AND METALLURGIC PRODUCTS AND GLOWING TEMPERATURES ACCORDING TO PLATTNER.

Tin.....	228°	<i>Yellow heat</i>	1200°
Bismuth.....	264	<i>White heat</i>	1300
Thallium.....	290	Slag of lead and lead	
Cadmium.....	320	"stein".....	1315°-1330
Lead.....	335	Slag of black copper..	1345
Zinc.....	412	Slag from iron fur-	
Antimony.....	432	nace.....	1390-1430
<i>Incipient red heat</i>	525	Cobalt.....	1400
Aluminum.....	700	<i>Dazzling white heat</i>	1500-1600
Magnesium.....	700	White raw iron.....	1600
<i>Cherry red heat</i>	900	Grey raw iron.....	1700
Bronze.....	900	Palladium.....	1600
Red lead.....	954	Nickel.....	1600
Silver.....	916	Manganese.....	1600
<i>Complete cherry heat</i>	1000	Uranium ..	1600
Mat of copper.....	1002	Molybdenum.....	1600
Brass.....	1015	Tungsten.....	1700
Mat of lead.....	1027	Chromium.....	1700
Black copper.....	1027	Steel.....	1700-1900
Gold.....	1087	Wrought iron.....	1900-2100
Copper.....	1090	Platinum.....	2000

105. FUSING POINTS OF GOLD AND SILVER AND GOLD AND PLATINUM ALLOYS.

AFTER ERHARD AND SCHERTEL.

Silver.	Gold.	Melting Point	Gold.	Platin.	Melting Point.
100	....	954°	80	20	1190°
80	20	975	60	40	1320
60	40	995	40	20	1460
40	60	1020	20	80	1610
20	80	1045	....	100	1775
....	100	1075	....	....	....

106.

COMPOSITION OF IMPORTANT ALLOYS.

	Gold.	Silver.	Copper.	Tin.	Lead.	Zinc.	Nickel.	Antimony.	Aluminum.
Gold jewelry and plate....	75 to 92	..	25 to 8	...	...	...	...	...	...
Silver jewelry.....	80	20	...	...	...	...	...	...	...
Silver vessels.....	95	5	...	...	...	...	...	...	...
Bronze coins.....	...	94-96	4-6	...	...	1.5	...	...	...
Bronze cannon.....	...	90	10.0	...	...	...	...	...	...
Bronze bells.....	...	78	22.0	...	...	...	...	...	...
Bronze cymbals.....	...	80	20.0	...	...	...	...	...	...
Aluminum bronze.....	...	90-95	...	...	...	...	...	...	5-10
Brass.....	...	67-72	...	...	...	33-38	...	...	...
Pinchbeck.....	...	90	...	...	...	10.0	...	...	...
German silver.....	...	50	...	...	...	25.0	25	...	...
Type metal.....	...	...	...	80.0	...	...	20	...	...
Pewter.....	...	...	92.0	8.0	...	...	...	...	...
Plumber's solder.....	...	...	67.0	33.0	...	...	...	...	...
Anti-friction metal.....	...	...	38.0	52.0	...	...	10	...	...
U. S. gold coin.....	90	10	...	...	...	...	...	...	...
U. S. silver coin.....	90	10	...	...	...	...	...	...	...
U. S. nickel coin.....	...	75	...	...	...	...	25	...	...
U. S. copper coin.....	...	95	2.5	...	...	2.5	...	...	...

107.

PECUNIARY VALUE OF METALS.

	Price per av. lb.		Price per av. lb.
Glucinum.....	\$5.50 00	Platinum.....	\$150 00
Rubidium.....	5.50 00	Manganese.....	70 00
Calcium.....	4.50 00	Thallium.....	21 00
Zirconium.....	4.50 00	Potassium.....	18 50
Didymium.....	4.00 00	Molybdenum.....	14 00
Indium.....	4.00 00	Silver.....	12 50
Cerium.....	3.50 00	Tungsten.....	9 00
Erbium.....	3.50 00	Tungsten, commercial	1 50
Lithium.....	3.50 00	Cobalt.....	5 25
Vanadium.....	3.50 00	Magnesium.....	4 80
Yttrium.....	3.50 00	Bismuth.....	2 00
Rhodium.....	2.50 00	Sodium.....	2 00
Ruthenium.....	2.50 00	Cadmium.....	1 00
Niobium.....	2.25 00	Aluminum.....	0 75
Barium.....	2.00 00	Mercury.....	0 70
Titanium.....	1.00 00	Nickel.....	0 60
Uranium.....	900 00	Tin.....	0 18
Palladium.....	680 00	Antimony.....	0 16
Chromium.....	450 00	Copper.....	0 12½
Gold.....	301 50	Arsenic.....	0 09
Osmium.....	300 00	Zinc.....	0 05
Strontium.....	275 00	Lead.....	0 04½
Iridium.....	220 00	Pig Iron.....	0 007

108. WEIGHT AND FINENESS OF UNITED STATES COINS.**I.—GOLD.**

Name of Coin.	Weight in grams.	Fineness in 1000 parts.	Fineness in grams.
Double eagle.....	33.4363	900	30.0926
Eagle.....	16.7181	900	15.0463
Five dollar.....	8.3591	900	7.5232
Two and one-half dollar.....	4.1795	900	3.7616
Dollar.....	1.6718	900	1.5046

II.—SILVER.

Dollar.....	27.2156	900	24.4940
One-half dollar.....	12.5	900	11.25
One-quarter dollar.....	6.25	900	5.625
Dime.....	2.5	900	2.25

III.—SMALLER COIN.

Five cents.....	5.0	....	....
One cent.....	3.944	....	....

109. UNITED STATES MINT TEST FOR GOLD AND SILVER.

The following is a test for determining whether a coin is good or bad. Use the liquids as near the edge of the suspected coin as possible, as that is the part most worn. A drop of the preparation will have no effect on genuine coin, while its action can be plainly seen on the counterfeit. Heavily plated coins should be scraped slightly before applying test solutions.

TEST FOR GOLD.	TEST FOR SILVER.
Strong Nitric Acid, $6\frac{1}{4}$ drachms.	24 grains Silver nitrate.
Muriatic Acid, $\frac{1}{4}$ drachm, or 15 drops.	30 drops Nitric Acid.
Water, 5 drachms.	1 ounce water.

Diameter, thickness and weight of the coins ought to be examined in conjunction with these tests.

MINERAL PRODUCTS OF THE UNITED STATES.

Calendar Years 1880 to 1890.

PRODUCTS.	1880.		1881.		1882.	
	Quan- tity.	Value.	Quan- tity.	Value.	Quan- tity.	Value.
METALLIC.						
Pig iron, value at Philadelphia,	3,375,912	\$88,315,569	4,144,254	\$87,029,334	4,621,323	\$106,886,429
Silver, coining value (d),	30,330,000	39,200,000	88,077,000	43,000,000	86,197,695	46,800,000
Gold, coining value (e),	1,741,500	36,000,000	1,676,900	34,700,000	1,572,186	32,500,000
Copper (f), value at New York City,	60,480,000	11,491,200	71,680,000	12,175,600	91,646,262	16,088,091
Lead, value at New York City,	97,825	9,782,500	117,085	11,240,160	132,990	12,624,550
Zinc, value at New York City,	23,220	2,277,432	26,800	2,680,000	33,765	3,646,620
Quicksilver, value at San Francisco,	59,926	1,737,780	60,851	1,764,679	52,732	1,487,042
Nickel (h), value at Philadelphia,	329,968	164,984	265,668	292,235	281,616	309,777
Aluminum, value at Pittsburgh,	(i)	10,000	(i)	10,000	(i)	12,000
Antimony, value at San Francisco,	100	400	100	400	200	600
Platinum, value (crude) at San Francisco,	.....	\$190,089,865	.....	\$192,892,408	.....	\$219,755,109
Total value of metallic products,						
Non-METALLIC (Spot Values b).						
Bituminous coal (k),	38,242,641	53,443,718	48,179,475	60,224,344	60,861,190	76,076,487
Pennsylvania anthracite,	26,580,189	42,196,678	26,500,016	64,125,036	81,366,264	70,556,094
Building stone, (m),	.....	18,356,055	.....	20,000,000	.....	21,000,000
Petroleum,	26,296,128	24,183,288	27,661,268	25,448,839	30,510,830	24,065,988
Lime,	28,000,000	19,000,000	30,000,000	20,000,000	31,000,000	21,700,000
Natural gas,	(i)	.....	(i)	.....	(i)	215,000
Salt,	2,079,943	1,852,707	2,500,000	2,000,000	3,290,000	8,672,750
Phosphate rock,	5,961,000	4,653,000	6,200,000	4,200,000	6,412,378	4,891,140
Limestone for iron flux,	211,377	1,123,826	266,734	1,980,259	332,077	1,982,462
Mineral waters,	4,500,000	3,900,000	6,400,000	4,100,000	8,850,000	2,310,000
Mineral waters, ... gallons sold,	2,000,000	500,000	3,700,000	700,000	5,000,000	800,000

Zinc-white,	short tons,	10,107	763,738	10,000	700,000	10,000	700,000
Potters' clay,	long tons,	23,733	230,457	23,000	230,000	80,000	240,000
Mineral paints,	..	3,604	135,840	6,000	100,000	7,000	105,000
Borax,	pounds,	3,692,443	277,233	4,046,000	804,461	4,238,291	838,908
Gypsum,	short tons,	30,000	400,000	35,000	350,000	100,000	450,000
Grindstones,	..	..	..	..	..	..	..
Fibrous talc,	..	..	..	..	..	..	..
Pyrites,	short tons,	4,210	54,730	5,000	60,000	6,000	75,000
Soapstone,	long tons,	2,000	5,000	10,000	60,000	12,000	72,000
Manganese ore,	short tons,	8,441	66,665	7,000	75,000	6,000	67,900
Asphaltum,	long tons,	5,761	86,415	4,335	73,425	4,532	67,940
Precious stones,	short tons,	444	4,440	2,000	8,000	3,000	10,500
Bronze,	..	..	..	..	..	..	..
Corundum,	pounds,	404,690	114,752	300,000	75,000	250,000	75,000
Barytes (crude),	short tons,	1,044	29,280	500	80,000	500	80,000
Graphite,	long tons,	20,000	80,000	30,000	80,000	20,000	80,000
Millstones,	pounds,	..	..	..	..	..	..
Novaculite,	..	..	..	..	..	..	..
Marls,	..	..	..	..	..	..	..
Flint,	short tons,	420,000	8,000	500,000	8,530	600,000	10,000
Fluorspar,	long tons,	1,000,000	500,000	1,000,000	500,000	1,080,000	540,000
Chromic iron ore,	..	..	..	..	..	..	..
Infusorial earth,	short tons,	20,000	80,000	25,000	100,000	25,000	100,000
Felspar,	long tons,	4,000	16,000	4,000	16,000	4,000	20,000
Mica,	..	..	..	..	..	..	..
Ozocerite, refined,	..	..	..	..	..	..	..
Cobalt oxid,	..	..	..	..	..	..	..
Slate ground as a pigment,	..	..	..	..	..	..	..
Sulfur,	..	..	..	..	..	..	..
Asbestos,	..	..	..	..	..	..	..
Rutile,	..	..	..	..	..	..	..
Lithographic stone,	pounds,	100	400	200	700	500	1,800
..	short tons,	(f)	..	50	1,000	(f)	..
Total value of non-metallic mineral products,	..	..	..	..	..	..	..
Total value of metallic products,	..	\$173,279,135	..	..	\$206,733,144	..	\$231,840,150
Estimated value of mineral products unspecified (u),	..	190,039,985	..	..	192,932,493	..	219,735,109
Grand total,	..	..	6,000,000	..	6,500,000	..	6,500,000
Grand total,	..	..	\$369,319,000	..	\$406,175,532	..	\$457,595,259

For explanation of references, see page 104.

110—Continued.

PRODUCTS.	1883.		1884.		1885.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
METALLIC.						
Pig iron, value at Philadelphia,	4,593,510	\$91,910,200	4,097,968	\$78,761,624	4,044,525	\$64,712,400
Silver, coinable value (d),	35,733,622	45,300,000	37,744,805	48,400,000	39,910,279	51,600,000
Gold, coinable value (c),	1,451,349	30,000,000	1,459,949	30,000,000	1,538,576	31,600,000
Copper (f), value at New York City,	117,151,725	18,064,807	145,221,864	17,739,637	170,962,677	18,282,999
Lead, value at New York City,	36,572	12,322,719	189,897	10,337,042	128,412	10,469,431
Zinc,	56,572	3,311,106	58,544	3,422,707	40,068	3,539,856
Quicksilver, value at San Francisco,	46,725	1,233,652	81,913	996,327	32,073	979,199
Nickel (h), value at Philadelphia,	58,500	52,920	64,550	48,412	277,904	179,975
Aluminum, value at Pittsburgh,	88	875	150	1,300	283	2,500
Antimony, value at San Francisco,	60	12,000	60	12,000	50	10,000
Platinum, value (crude) at San Francisco,	200	600	150	450	250	187
Total value of metallic products,	....	\$203,128,856	....	\$186,109,599	....	\$181,596,587
NON-METALLIC (Spot Values b).						
Bituminous coal (h),	68,851,300	\$2,287,800	73,730,539	77,417,066	64,840,668	\$2,347,648
Pennsylvania antiracite,	34,886,499	77,287,065	83,175,756	66,351,512	34,228,548	76,671,948
Building stone,	....	20,000,000	....	19,000,000	....	19,000,000
Petroleum,	23,449,638	20,790,252	24,218,488	20,585,966	21,847,205	19,196,243
Lime,	32,000,000	19,200,000	37,000,000	18,500,000	40,000,000	20,000,000
Natural gas,	....	475,000	....	1,460,000	....	4,887,200
Cement,	4,190,000	4,283,500	4,000,000	3,720,000	4,150,000	3,492,500
Salt,	6,192,231	4,211,042	6,514,987	4,197,734	7,088,653	4,826,345
Phosphate rock,	378,390	2,270,390	431,779	2,874,784	437,566	2,846,064
Limestone for iron flux,	9,814,273	1,907,136	8,401,980	1,700,965	8,356,566	1,678,478
Mineral waters,	7,529,423	1,119,603	10,215,328	1,459,143	9,148,401	1,312,845

Zinc-white,	short tons,	12,000	840,000	12,000	910,000	15,000	1,050,000
Potters' clay,	long tons,	32,000	290,000	35,000	270,000	36,000	275,000
Mineral paints,	"	7,000	84,000	7,000	84,000	8,550	43,575
Borax,	pounds,	6,500,000	585,000	7,000,000	490,000	8,000,000	480,000
Gypsum,	short tons,	90,000	420,000	90,000	390,000	90,405	405,000
Grindstones,	"	...	600,000	...	570,000	...	500,000
Fibrous talc,	short tons,	6,000	75,000	10,000	110,000	10,000	110,000
Pyrites,	long tons,	25,000	137,500	35,000	175,000	40,000	231,500
Soapstone,	short tons,	8,000	100,000	10,000	130,000	10,000	200,000
Manganese ore,	long tons,	6,155	92,325	10,190	122,160	23,258	190,281
Asphaltum,	short tons,	3,000	10,500	3,000	10,500	3,000	10,500
Precious stones,	"	...	207,050	...	222,975	...	209,900
Bromin,	pounds,	301,100	72,264	281,100	67,464	310,000	89,900
Corundum,	short tons,	550	100,000	600	108,000	600	108,000
Barytes (crude),	long tons,	27,000	108,000	25,000	100,000	15,000	75,000
Graphite,	pounds,	575,000	46,000	(f)	...	327,583	26,231
Millstones,	"	...	150,000	...	150,000	...	100,000
Novaculite,	pounds,	600,000	10,000	800,000	12,000	1,000,000	15,000
Marl,	short tons,	972,000	486,000	875,000	437,500	875,000	437,500
Flint,	long tons,	25,000	100,000	30,000	120,000	30,000	120,000
Fluorspar,	short tons,	4,000	20,000	4,000	20,000	5,000	22,500
Chromic iron ore,	long tons,	3,000	60,000	2,000	35,000	2,700	40,000
Infusorial earth,	short tons,	1,000	5,000	1,000	5,000	1,000	5,000
Felspar,	long tons,	14,000	71,112	10,900	55,112	13,600	68,000
Mica,	pounds,	114,000	285,000	147,410	398,525	92,000	161,000
Ozocerite, refined,	"	...	...	(f)	...	(f)	...
Cobalt oxid,	"	1,996	2,795	2,000	5,100	68,723	65,373
Slate ground as a pigment,	long tons,	2,000	24,000	2,000	20,000	1,975	24,087
Sulfur,	short tons,	1,000	27,000	500	12,000	715	17,875
Asbestos,	"	1,000	30,000	1,000	30,000	300	9,000
Rutile,	pounds,	550	2,000	600	2,000	600	2,000
Litographic stone,	short tons,	(f)	...	(f)	...	(f)	...
Total value of non-metallic mineral products,	"	...	\$243,812,214	...	\$221,879,506	...	\$241,312,093
Total value of metallic products,	"	...	203,128,859	...	186,109,599	...	181,536,587
Estimated value of mineral products unspecified (u),	"	...	6,500,000	...	5,000,000	...	5,000,000
Grand total,	"	...	\$453,441,073	...	\$412,989,105	...	\$427,898,680

For explanation of references, see page 106.

110—Continued.

PRODUCTS.	1886.		1887.		1888.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
METALLIC.						
Pig iron, value at Philadelphia, long tons (c),	5,683,929	\$95,195,780	6,417,148	\$121,925,800	6,488,738	\$107,000,000
Silver, coinage value (d), troy ounces,	38,445,312	51,000,000	41,285,240	53,850,000	45,783,632	59,195,000
Gold, coinage value (e), " "	1,881,250	33,000,000	1,596,540	33,000,000	1,604,927	33,175,000
Copper (f), value at New York City, pounds,	161,285,361	16,527,651	185,227,881	21,115,916	231,270,622	33,838,954
Lead, value at New York City, short tons,	138,629	12,567,749	160,700	14,463,000	180,555	15,924,951
Zinc, value at New York City, " "	42,641	3,752,408	50,340	4,782,300	55,908	5,500,855
Quicksilver, value at San Francisco, flasks (g),	29,961	1,060,000	38,825	1,429,000	33,220	1,413,125
Nickel (h), value at Philadelphia, pounds,	214,992	127,157	205,566	133,200	204,328	127,632
Aluminum, value at Pittsburgh, " "	3,000	27,000	18,000	59,000	19,100	65,000
Antimony, value at San Francisco, short tons,	35	7,000	75	15,000	100	20,000
Platinum, value (crude) at San Francisco, troy ounces,	50	100	448	1,888	500	2,000
Total value of metallic products, . . . .	....	\$215,384,825	....	\$250,275,054	....	\$256,257,517
NON-METALLIC (Spot Values b).						
Bituminous coal (i), long tons (n),	65,810,676	78,481,056	78,470,857	98,004,656	91,106,998	101,860,529
Pennsylvania anthracite, " (m),	34,853,077	76,119,120	37,578,747	84,552,181	41,624,611	89,020,483
Building stone, " "	28,064,841	19,996,313	28,278,866	18,877,044	27,612,025	17,947,620
Petroleum, " "	42,500,000	21,250,000	46,750,000	28,375,000	49,087,000	24,548,500
Lime, " (p),	10,012,000	10,012,000	15,817,500	15,817,500	22,629,875	22,629,875
Natural gas, " "	4,500,000	8,900,000	6,692,744	5,674,377	6,503,295	5,674,377
Cement, " (q),	7,707,081	4,758,583	7,881,962	4,083,846	8,065,881	4,371,208
Salt, " (r),	4,300,000	1,875,998	4,601,568	1,896,818	4,48,567	2,018,563
Phosphate rock, " "	4,717,163	2,800,297	5,377,000	3,226,200	5,498,000	2,719,000
Limestone for iron flux, " "	8,950,317	1,284,070	8,259,609	1,261,463	9,578,648	1,673,302
Mineral waters, " "	....	....	....	....	....	....

Zinc white,	18,000	1,440,000	18,000	1,440,000	20,000	1,600,000
Potters' clay,	40,000	320,000	40,000	320,000	36,730	300,000
Mineral paints,	13,380	283,000	20,000	310,000	24,000	380,000
Borax,	9,778,280	488,915	11,000,000	630,000	7,589,000	455,940
Gypsum,	96,230	428,625	96,000	425,000	110,000	550,000
Grindstones,	...	250,000	...	224,400	...	261,800
Fibrous talc,	12,000	125,000	15,000	160,000	20,000	210,000
Pyrites,	53,000	220,000	62,000	210,000	54,351	167,658
Soapstone,	12,000	225,000	12,000	225,000	15,000	250,000
Manganese ore,	30,198	277,696	34,524	333,844	29,198	279,571
Asphaltum,	3,500	14,000	4,000	16,000	53,800	331,900
Precious stones,	...	119,056	...	103,000	...	139,850
Bromin,	428,334	141,359	199,087	61,717	807,886	96,280
Corundum,	10,000	116,190	600	108,000	907,859	91,620
Barytes (crude),	415,525	50,000	15,000	75,000	20,000	110,000
Graphite,	...	33,232	416,000	34,000	400,000	88,000
Millstones,	1,160,000	140,000	1,200,000	100,000	1,500,000	81,000
Novaculite,	30,000	15,000	600,000	16,000	300,000	150,000
Flint,	80,000	400,000	82,000	390,000	30,000	175,000
Fluorspar,	5,000	120,000	5,000	185,000	6,000	90,000
Chromic iron ore,	2,000	22,000	3,000	40,000	1,500	20,000
Infusorial earth,	1,200	30,000	3,000	20,000	7,500	50,000
Felspar,	14,900	6,000	10,200	56,100	8,700	70,000
Mica,	40,000	70,000	70,000	142,250	48,000	3,000
Ozocerite, refined,	(t)	(t)	(t)	18,774	43,500	3,000
Cobalt oxid,	35,000	36,878	18,340	18,774	8,491	15,782
Slate ground as a pigment,	3,000	30,000	2,000	20,000	2,500	25,000
Sulfur,	2,500	75,000	3,000	100,000	(t)	3,000
Asbestos,	200	6,000	150	4,500	100	3,000
Rutile,	600	2,000	1,000	3,000	1,000	3,000
Lithographic stone,	40	700	(t)	...	(t)	...
Total value of non-metallic mineral products,	...	\$245,130,469	...	\$287,416,320	...	\$303,241,114
Total value of metallic products,	...	215,364,825	...	250,275,054	...	256,257,517
Estimated value of mineral products unsupplied (u),	...	5,000,000	...	5,000,000	...	5,000,000
Grand total,	...	\$465,504,294	...	\$542,691,374	...	\$564,498,631

For explanation of references, see page 106.

110—Continued.

PRODUCTS.	1889. (a)		1890.	
	Quantity.	Value.	Quantity.	Value.
METALLIC.				
Pig iron, value at Philadelphia, . . . long tons (c),	7,608,642	\$120,000,000	9,232,708	\$151,200,410
Silver, coinage value (d), . . . troy ounces,	51,884,881	66,896,988	64,500,000	70,464,645
Gold, coinage value (e), . . . " . . .	1,590,969	32,896,744	1,596,880	32,945,000
Copper (f), value at New York City, . . . pounds,	281,246,214	26,907,809	265,115,188	30,848,797
Lead, value at New York City, . . . short tons,	182,987	16,137,689	161,764	14,266,708
Zinc, value at New York City, . . . " . . .	68,980	5,791,824	68,668	6,266,407
Quicksilver, value at San Francisco, . . . flasks (g),	26,484	1,190,500	22,926	1,208,615
Nickel (h), value at Philadelphia, . . . pounds,	252,668	151,598	225,488	134,083
Aluminum, value at San Francisco, . . . short tons,	(f) 47,468	97,885	(f) 61,261	134,083
Antimony, value at San Francisco, . . . troy ounces,	115	28,000	126	40,756
Platinum, value (crude) at San Francisco, . . .	500	2,000	600	2,500
Total value of metallic products, . . .	....	\$289,590,487	....	\$307,884,207
Non-METALLIC (Spot Values b).				
Bituminous coal (b), . . . long tons (h),	88,388,059	94,846,809	99,392,871	110,420,801
Pennsylvania anthracite, . . . (m),	40,714,721	65,879,514	41,489,868	61,445,683
Building stone, . . . barrels (o),	88,168,513	26,682,840	45,000,000	37,000,000
Petroleum, . . . " (p),	68,474,668	38,217,015	60,000,000	35,000,000
Lime, . . . barrels (q),	7,000,000	21,067,099	8,000,000	20,000,000
Natural gas, . . . long tons,	8,000,000	5,000,000	8,000,000	4,000,000
Cement, . . . " (r),	8,000,000	4,185,412	8,776,991	4,782,286
Salt, . . . long tons,	350,245	2,987,776	510,499	3,218,795
Phosphate rock, . . . gallons sold,	6,318,000	3,159,000	5,321,622	2,760,811
Limestone for iron flux, . . .	12,780,471	1,748,468	12,910,708	2,091,189
Mineral waters, . . .				

Zinc-white,	.	.	.	16,970	1,357,600	890,000	1,600,000
Potters' clay,	.	.	short tons,	294,344	635,578	890,000	766,000
Mineral paints,	.	.	long "	32,307	463,776	45,752	661,992
Borax,	.	.	pounds,	8,000,000	500,000	9,500,000	617,500
Gypsum,	.	.	short tons,	287,769	764,118	152,995	574,523
Grindstones,	.	.	short tons,	...	439,587	450,000	450,000
Fibrous talc,	.	.	short tons,	23,746	244,170	41,854	389,196
Pyrites,	.	.	long tons,	53,705	202,119	111,886	273,745
Soapstone,	.	.	short tons,	12,715	231,708	13,670	252,309
Manganese ore,	.	.	long tons,	24,197	240,559	25,684	219,050
Asphaltum,	.	.	short tons,	51,735	171,537	40,841	190,416
Precious stones,	.	.	short tons,	...	181,897	...	118,583
Bromin,	.	.	pounds,	418,891	125,667	387,847	104,719
Corundum,	.	.	short tons,	2,245	145,565	1,970	89,395
Barytes (crude),	.	.	long tons,	19,161	106,313	21,911	86,345
Graphite,	.	.	pounds,	...	72,662	...	77,540
Millstones,	.	.	...	...	35,155	...	73,720
Novaculite,	.	.	pounds,	5,982,000	32,940	...	69,949
Marls,	.	.	short tons,	139,522	63,956	153,620	69,880
Flint,	.	.	long tons,	11,113	49,137	13,620	57,400
Fluorspar,	.	.	short tons,	9,500	45,835	8,250	55,528
Chromic iron ore,	.	.	long tons,	2,000	30,000	8,599	53,965
Infusorial earth,	.	.	short tons,	8,466	23,572	2,532	50,240
Felspar,	.	.	long tons,	6,970	39,570	8,000	45,340
Mica,	.	.	pounds,	49,540	50,000	60,000	75,040
Opacite, refined,	.	.	"	50,000	2,500	350,000	26,250
Orbait oxid,	.	.	long tons,	13,953	81,092	6,788	16,291
Slate ground as a pigment,	.	.	short tons,	1,150	7,880	2,000	20,000
Sulfur,	.	.	short tons,	30	1,800	71	4,560
Asbestos,	.	.	pounds,	1,000	3,000	400	1,000
Rutile,	.	.	short tons,	18	243	...	...
Lithographic stone,	.	.	short tons,	...	...	...	...
Total value of non-metallic mineral products,	.	.		...	\$37,640,175	...	\$34,765,011
Total value of metallic products,	.	.		...	249,350,357	...	377,354,207
Estimated value of mineral products unspecified (u),	.	.		...	10,000,000	...	10,000,000
Grand total,	.	.		...	\$387,230,662	...	\$452,099,218

For explanation of references, see page 103.

110—Continued.

EXPLANATION OF REFERENCES.

a. The results for 1889, with the exception of lime, cement, salt, zinc-white, borax, bromin, slate ground as a pigment and rutile, were obtained through the Eleventh United States Census.

b. By "spot" value is meant value at the point of production.

c. "Long" tons are tons of 2,240 avoirdupois pounds; short tons are tons of 2,000 avoirdupois pounds.

d. \$1.2229 per troy ounce.

e. \$20.6718 per troy ounce.

f. Including copper made from imported pyrites, except in 1881, for which no returns are available for matte.

g. Of 76½ avoirdupois pounds net.

h. Including nickel in copper-nickel alloy, and in exported ore and matte.

i. Not reported.

j. Including aluminum alloys.

k. Including brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania.

l. The commercial product of bituminous coal, that is, the amount marketed, was only:

YEARS.	QUANTITY.	VALUE.
1882	57,968,038.	\$72,453,797
1883	65,080,171.	78,066,205
1884	66,809,356.	70,149,824
1885	63,569,284.	80,640,564
1886	63,980,119.	75,554,629
1887	75,454,464.	94,280,732
1888	87,602,594.	118,573,141
1889	65,723,110.	72,878,784
1890	78,011,224.	86,496,845

m. The commercial product of anthracite, that is, the amount marketed, was only:

YEARS.	QUANTITY.	VALUE.
1882	29,120,096.	\$65,520,216
1883	31,798,027.	71,594,811
1884	30,718,293.	61,436,596
1885	32,265,421.	72,274,544
1886	32,764,710.	71,558,126
1887	35,273,442.	79,965,244
1888	39,216,872.	72,557,213
1889	35,868,280.	63,468,572
1890	36,617,042.	58,645,854

n. Not including lime in barrels, limestone for iron flux, or grind-stones.

o. Of 42 gallons.

p. Of 200 pounds.

q. Of 800 pounds for natural cement, and 400 for artificial Portland.

r. Of 280 pounds net.

s. Value of the crude product.

t. Including cobalt oxid in ore and matte.

u. Including fire-clay, common brick clay, terra cotta, building sand, glass sand, limestone used as flux in lead smelting, limestone in glass-making, iron ore used as flux in lead smelting, tin ore, iridosmine, nitrate of soda, carbonate of soda, sulfate of soda, native alum, mineral soap, strontia, and pumice-stone.

III. TAWING OR TANNING BY MEANS OF CHROMIUM COMPOUNDS.

A great amount of attention has been devoted to the application of chromium compounds in the art of mineral tanning. Results have been obtained superior to those obtained by the use of vegetable tanning materials. As the resistance against water is one of the most important properties of leather, a leather which absorbs water slowly and in smaller quantity than another is to be considered the preferable product. The attached table shows how to test leather in this regard, and at the same time illustrates the superiority of chrome tanned leather.

Time Exposed to the Action of Water.	Bark-Tanned Leather.									
	Sole Leather A.				Sole Leather B.				Calves' Leather.	
	Weight, Grams.	Increase, Per cent.	Thickness, mm.	Increase, Per cent.	Weight, Grams.	Increase, Per cent.	Thickness, mm.	Increase, Per cent.	Weight, Grams.	Increase, Per cent.
At the beginning	2.43	....	3.45	....	2.40	....	4.25	....	1.5	....
After 35 minutes.....	3.03	24.7	4.25	23.1	3.50	42.8	4.75	11.7	2.3	53.3
After 16 hours	3.33	37.0	4.60	33.3	3.30	34.7	4.60	8.2	2.5	66.6
After 4 days	3.33	37.0	4.60	33.3	3.60	46.9	4.70	10.6	2.56	70.6
Time Exposed to the Action of Water.	Chrome-Tanned Leather.									
	Sole Leather E.								Calves' Leather F.	
	Weight, Grams.	Increase, Per cent.	Thickness, mm.	Increase, Per cent.					Weight, Grams.	Increase, Per cent.
At the beginning	2.66	....	4.75	....	....	....	....	....	1.50	....
After 35 minutes.....	2.66	0.0	4.75	0.0	....	....	....	....	1.50	0.0
After 16 hours	2.83	6.4	5.00	5.0	....	....	....	....	1.66	10.6
After 4 days.....	3.21	20.4	5.20	5.2	....	....	....	....	2.30	53.3

A great many processes for the execution of chrome tanning have been patented, the principle of all of which is: The depilated, soaked and softened hides are impregnated with chromic and other metallic compounds. Part of these compounds is deposited in the pores of the hide by either the reducing action of the hide substance itself or by the action of chemical reducing agents.

In tabular form we give the composition of the baths used in the best known processes.

CAVALIN'S PROCESS.

- I. 100 parts of water, 6 parts potassium bichromate, 12 pts. water.
- II. 100 parts of water, 10 parts ferrous sulfate.

BALLATSHANOS' AND TRENK'S PROCESS.

- I. 2% aluminum chromate, 3% pyrolignous acid.
- II. Concentrated solution of argols (potassium bitartrate). Finish by tanning with bark as usual.

VANDERSTRAATEN'S PROCESS.

Hides are tanned slightly by Valonia or Mimosa bark.

- I. Bichromate or chromate of potassium, or alum, or aluminum sulfate or salts of iron.
- II. Solution of gelatine.

HEINZERLING'S PROCESS.

- I. Zinc dust or cuttings in a 5% to 10% alum solution produce an amorphous precipitate of alumina on the hide.
- II. $\frac{1}{4}$ to 5% chromates, 1 to 10% alum or its equivalent of aluminum sulfate. Ferro or ferri potassium cyanid, small quantity.
- III. Weak solution of lead acetate or barium chlorid.
- IV. Stearine, paraffine or resin dissolved in benzene.

SCHULTZ'S PROCESS.

- I. For 100 lbs. of hide 4 or more lbs. of potassium bichromate, 2 lbs. hydrochloric acid and 4 gallons of water.
- II. A. 10 lbs. potassium or sodium thiosulfate and $2\frac{1}{2}$ lbs. hydrochloric acid.
- II. B. 10 lbs. potassium or sodium sulfite and $2\frac{1}{2}$ lbs. hydrochloric acid.

ORDWAY'S PROCESS.

- I. Cold saturated solution of potassium bichromate. Exposure to sunlight.

WARTER AND KOEGEL'S PROCESS.

For 100 lbs. of hide:

- I. 12-15 gals. of water, 9 lbs. of alum, 2 lbs. common salt, 30 lbs. of wheat flour—heated to 28 to 30° C., then addition of 12 lbs. of egg yolk.
- II. 1 lb. of soda in 1 gal. of water.
- III. Sulfuric acid 1 to 2° B_é., chromic hydrate in excess.

ZAHN'S PROCESS.

For 100 lbs. of hide:

- I. Potassium bichromate, 5 lbs.; common salt, 2 lbs.; hydrochloric acid, $2\frac{1}{2}$ lbs.; 5 gal. of water.
- II. 8 lbs. sodium thiosulfate and $\frac{1}{2}$ lb. sulfuric acid of 60 to 65° B_é. in 10 gal. of water.
- III. 10 ozs. neatsfoot oil saponified by 2 ozs. caustic soda in 1 gal. of water, extract of 5 lbs. of Quercitron bark or other suitable tanning extract.

ENDEMANN'S PROCESS.

For 100 lbs. of hide:

- I. 5 lbs. potassium bichromate, 2 lbs. common salt, $\frac{1}{2}$ lb. hydrochloric acid and 5 gals. of water.
- II. $2\frac{3}{4}$ lbs; copper sulfate, 30 lbs. common salt, 6 lbs. alum, and 25 gals. water. This solution is treated with metallic copper in order to reduce the cupric salt to cuprous salt.

OLLESTAD'S PROCESS.

For 10 "ordinary" hides :

- I. 10 to 15 barrels of water, 40 lbs. tanning extract, 20 lbs. alum, 10 lbs. copper sulfate, 8 lbs. sulfuric acid, $1\frac{1}{4}$ potassium bichromate.
- II. Lye extracted from maplewood ash mixed with boiled train-oil, or a mixture of $\frac{1}{4}$ train-oil and $\frac{1}{4}$ resin.

REVEIRE'S PROCESS.

Hides and skins previously tanned with vegetable tanning materials are mordanted in a neutral or basic solution of 1° to 1 $\frac{1}{4}$ ° Bé. of chromic oxid for the subsequent coloring process.

RAPPE'S PROCESS.

Hides and skins previously tanned :

- I. Chromic hydrate is dissolved in a bath of 4° Bé. of sulfuric or nitric acid.
- II. Warm solution of logwood.

112. COMPOSITION OF TANNING MATERIALS OF VARIOUS ORIGIN.

	Tanning substance.			Tanning substance after Löwenthal.		
	Low grade.	Medium.	Best.	Low grade.	Medium.	Best.
Oak bark.....	5.94	10.10	15.91	4.24	4.45	12.18
Pine tree bark.....	7.15	11.59	17.95	4.21	7.31	12.26
Fir tree bark.....	4.00	6.00	8.00	.....	.....	.....
Alder tree bark.....	3.00	4.00	5.00	.....	.....	.....
Hemlock tree bark.....	5.00	6.50	8.00	.....	.....	.....
Mimosa bark, Australia...	22.04	31.89	41.26	14.91	23.19	30.34
Valonia, Asia Minor....	19.62	28.57	41.17	14.70	24.19	33.69
Knoppenn, Hungary.....	.....	40.00	.....	.....	.....	.....
Algorabilla, Chile.....	.....	43.20	.....	.....	27.00	.....
Myrobalan, India.....	18.00	30.26	30.00	15.00	25.21	30.00
Divi-Divi, West Indies....	31.80	41.40	51.00	26.50	34.50	42.50
Catechu, India.....	40.00	45.00	50.00	.....	.....	.....
Gambir, India.....	40.00	35.00	50.00	.....	.....	.....
Kino, India and Australia.	30.00	35.00	49.00	.....	.....	.....

113.

COMPOSITION OF TANNING EXTRACTS.

	Tanning substance.	Not tanning substances	Water.	Ash.	Insoluble.	Tannin, after Löwenthal.
Oak bark, Hungarian.....	31.06	15.50	49.07	2.25	2.12	19.04
Oak bark, French.....	21.51	5.58	69.68	1.85	1.38	13.65
Hemlock bark.....	25.37	15.66	48.64	1.33	9.00	14.89
Oak wood, Slavonian.....	22.92	16.93	56.50	1.24	2.41	21.70
Oak wood, French.....	30.23	8.28	58.61	1.78	1.10	24.73
Pine tree wood.....	25.29	26.36	39.88	2.42	6.05	13.90
Chestnut wood, German...	27.73	12.02	58.34	0.34	1.57	25.27
Chestnut wood, French...	31.27	7.24	60.80	0.57	0.12	27.77
Chestnut wood, English...	30.36	11.70	56.04	0.71	1.19	27.14
Quebracho wood, French	45.44	4.89	41.79	0.59	7.29	40.06
Valonia.....	24.68	17.25	52.82	2.59	2.66	23.52
Knopperrn, Hungary.....	34.65	8.29	47.70	3.13	6.23	.....
Sumach, French.....	21.01	24.57	49.25	2.71	2.46	17.31
Sumach, American.....	30.95	18.68	47.46	2.81	0.10	29.54
".....	28.40	19.20	49.27	3.01	0.12	27.12

114. AMOUNT OF TANNING MATERIAL REQUIRED FOR TANNING
ONE POUND OF HIDE.

Oak bark.....	4 to 10 lbs.	Mountain ash bark.....	6 lbs.
Oak leaves.....	10 "	Cherry tree bark.....	10 "
Alder tree bark.....	18 "	Larch tree bark.....	8 "
Beech tree bark.....	18 "	Mulberry tree bark.....	18 "
Ash tree bark.....	10 "	Walnut tree bark.....	8 "
Aspen tree bark.....	10 "	Willow tree bark.....	8 to 10 "
Fir tree bark.....	8 "	Galls.....	1 1/4 "
Maple tree bark.....	10 "	Knopperrn.....	2 "
Acacia bark.....	10 "	Sumach.....	3 "
Birch tree bark.....	10 "	Strawberry tree.....	10 "
Hazel tree bark.....	10 "	Bilberry bush.....	20 "
Elder tree bark.....	18 "	Cranberry bush.....	18 "

C.—MISCELLANEOUS PART.

115. FIRST AID IN ACCIDENTS.

The authors do not intend to give, in the following pages, advice which will render a doctor's services unnecessary. They wish simply to mention the right measures to be taken before the physician arrives.

WOUNDS.—The first principle is: "Do no harm." No lint or sticking plaster, nor sponges which have been used before, must be brought in contact with the wound, nor must it be touched with dirty fingers. If any dirt has entered the wound, the latter and the surrounding parts ought to be washed or rinsed with boiled water, to which carbolic acid (10 to 15 grains to the ounce of water) or bichloride of mercury ($\frac{1}{4}$ grain to the ounce) is added.

If there is a hemorrhage, an elastic bandage, made of India Rubber, is to be applied, after the wound is properly dressed with clean linen soaked in one of the above-named solutions. If a rubber bandage is not at hand, a linen bandage may be resorted to; or, if nothing else is to be had, a handkerchief may be bound as tightly as possible.

BURNS.—What can be done in case a person's clothing has caught fire? They ought to throw themselves on the ground and roll about, thus extinguishing the flames by pressure. Only after the flames are put out should the afflicted person be drenched with water.

In scalding by boiling water or steam (boiler explosion), cold water should be plentifully poured over the person. A very important question is, how the clothes should be removed. As a matter of course they ought not to be pulled nor torn off, as by such a cruel procedure the blisters would be broken, the skin torn off, and the poor patient deprived of a good protection for the raw surface. The proper way to do is to cut through the clothing with a good large pair of scissors in such a manner that it falls off of itself. The blisters should not be broken, as by doing so the raw surface would be exposed. They may be pricked at their lower ends with a clean new needle, so as to let the fluid out. If no doctor has arrived yet, the burnt surface ought to be protected in order to keep the air off. This can be done by covering the wound with a piece of linen or absorbent cotton soaked in oil (any oil at hand will do), or by putting on some dusting powder, as bismuth, bicarbonate of soda, starch or flour. Compresses of cold water should not be used, as they increase the suffering. An old, well-known remedy is linseed oil and lime water.

In burning, through caustics, the effects may be neutralized by some acid—by washing the injured part with vinegar and water, or diluted sulfuric acid. Then oil or powder are to be applied, as in the case of ordinary burns.

If the burns are produced by acids (sulfuric acid, nitric acid, etc.) it is necessary, besides washing the injured parts freely with water, to use whatever alkali may be at hand (soda or lime water). Vichy or seltzer water from a siphon will answer the purpose very well.

SUFFOCATION produced by inhaling noxious gases.—The first thing to be done is to bring the unconscious person into the fresh air. But in doing so the person who attempts the rescuing must be on his guard lest he himself should be affected by the noxious atmosphere. He must, above all, try to establish a through draught. The quickest and surest way is to break the window panes. If there is an access to the windows from the outside, the windows ought to be broken without the rescuing person entering the room. If, however, this is not possible, the person ought to cover mouth and nose with a cloth or sponge soaked in vinegar and water, to take a deep breath at the door of the room, rush to the nearest window, break a pane, put the head through it, take in fresh breath, rush to the next, and so on till the through draught has dispersed the vapor and the unconscious person can be removed. The door has of course to be left open.

If gas has escaped into a room, one must of course not enter it with a light.

After the person is brought into the fresh air, cold water ought to be poured over him, stimulants used (if a Faradic battery is at hand, it may be resorted to), and artificial respiration ought to be applied. The latter can be done in the following manner: One has to open the mouth of the affected person, pull out the tongue over the teeth with thumb and index finger of the left hand. With the right hand the abdomen has to be pressed 15 to 20 times per minute, as by pressing and relieving the abdomen the lungs become compressed and expanded. As to the stimulants, ammonia or vinegar may be applied to the nose, and mustard put on the region of the heart.

116. HOW PATENTS ARE ISSUED.

All patents shall be issued in the name of the United States, and under the seal of the Patent Office, signed by the Secretary of the Interior, and they shall be recorded, together with the specifications, in the Patent Office in books kept for that purpose.

Any person who has invented or discovered any new and useful art, machine, manufacture or composition of matter, or any new or useful improvement thereof, not known or used by others in this country, and not patented or described in any printed publication in this or any foreign country before the invention or discovery thereof, and not in public use or on sale for more than two years prior to his application, unless the same is proved to have been abandoned; and any person who by his own industry, genius, efforts and expense has invented and produced any new and original design for a manufacture, bust, statue, *alto-relievo* or *bas-relief*, or any new and original design for the printing of woollen, silk, cotton or other fabrics; any new and original impression, ornament, patent, pattern, print, or picture to be painted, printed, cast or otherwise placed on or worked into any article of manufacture; or any new, useful and original shape or configuration of any article of manufacture, the same not having been known or used by others before his invention or production thereof, or patented or described in any printed publication, may, upon payment of the fee prescribed and other due proceedings had, obtain a patent on the same.

Every patent shall contain a short title or description of the invention or discovery, correctly indicating its nature and design, and a grant to the patentee, his heirs or assigns, for the term of seventeen years, of the exclusive right to make, use and vend the

invention or discovery throughout the United States and the Territories, referring to the specification for the particulars thereof.

Whenever it appears that a patentee, at the time of making his application, believed himself to be the original and first inventor or discoverer, the same will not be refused on account of the invention or discovery or any part thereof having been known or used in a foreign country before his invention or discovery thereof, if it had not been patented or described in a printed publication.

No person shall be debarred from receiving a patent for his invention by reason of its having been first patented in a foreign country, unless the same has been introduced into public use in the United States for more than two years prior to the application. But every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent, or if there be more than one, at the same time with the one having the shortest term, but in no case shall it be in force more than seventeen years.

Joint inventors are entitled to a joint patent; neither can claim one separately. Independent inventors of distinct and independent improvements in the same machine cannot obtain a joint patent for their separate inventions; nor does the fact that one furnishes the capital and another makes the invention entitle them to make application as joint inventors; in such cases they may become joint patentees.

APPLICATIONS.—Application for a patent must be made in writing to the Commissioner of Patents. The applicant must also file in the Patent Office a written description of the name, and of the manner and process of making, constructing, compounding and using it, in such full, clear, concise and exact terms as to enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, compound and use the same; and in case of a machine, he shall explain the principle thereof, and the best mode in which he has contemplated applying that principle, so as to distinguish it from other inventions; and particularly point out and distinctly claim the part, improvement or combination which he claims as his invention or discovery. The specification and claim shall be signed by the inventor and attested by two trustees. When the nature of the case admits of drawing, the applicant shall furnish one copy signed by the inventor or his attorney in fact, and attested by two witnesses, which shall be filed in the Patent Office. When the invention and discovery is of a composition of matter, the applicant, if required by the Commissioner, shall furnish specimens of ingredients and of the composition sufficient in quantity for the purposes of experiments.

The applicant shall make oath that he does verily believe himself to be the original and first inventor and discoverer of the art, machine, manufacture, composition or improvement for which he solicits a patent; that he does not know and does not believe that the same was ever before known or used, and shall state of what country he is a citizen. Such oaths may be made before any person within the United States authorized by law to administer oaths, or, when the applicant resides in a foreign country, before any minister, charge d'affairs, consul or commercial agent holding commission under the Government of the United States, or before any notary public of the foreign country in which the applicant may be.

On the filing of any such application and the payment of the fees required by law, the Commissioner of Patents shall cause an examination to be made, and if, on such examination, the claimant is

justly entitled to a patent under the law, and the same is sufficiently useful and important, the Commissioner shall issue a patent therefor.

ASSIGNMENTS.—Every patent or any interest therein shall be assignable in law by an instrument in writing, and the patentee or his assigns or legal representatives may in like manner grant and convey an exclusive right under his patent to the whole or any specified part of the United States.

CAVEATS.—A caveat under the patent law is a notice given to the office of the caveator's claim as inventor, in order to prevent the grant of a patent to another for the same alleged invention upon an application filed during the life of the caveat without notice to the caveator.

Any citizen of the United States who makes any new invention or discovery, and desires more time to mature the same, may, on payment of the fees required by law, file in the Patent Office a caveat setting forth the design thereof, and of its distinguishing characteristics, and praying protection of his right until he shall have matured his invention. Such caveats shall be filed in the confidential archives of the office and preserved in secrecy, and shall be operative for the term of one year from the filing thereof.

An alien shall have the privilege herein granted, if he has resided in the United States one year next preceding the filing of his caveat, and has made oath of his intention to become a citizen.

FEES.—The following shall be the rates for patent fees:

On filing each original application for a patent (except in design cases), \$15.

On issuing each original patent (except in design cases), \$20.

In design cases: For three years and six months, \$10; for seven years, \$15; for fourteen years, \$30.

On filing each caveat, \$10.

On every application for the re-issue of a patent, \$30.

On filing each disclaimer, \$10.

On every application for the extension of a patent, \$50.

On the granting of every extension of a patent, \$50.

For certified copies of patents and other papers, including certified printed copies, 10 cents per hundred words.

For recording every assignment, agreement, power of attorney or other paper, of three hundred words or under, \$1; of over three hundred words and under one thousand words, \$2; of over one thousand words, \$3. For copies of drawings, the reasonable cost of making them.

117. POSTAL INFORMATION.

On all LETTERS throughout the United States or Dominion of Canada, 2 cents for each ounce or fraction thereof.

DROP OR LOCAL LETTERS, 2 cents where there is a free carriers' delivery. At other offices, 1 cent.

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Valuable letters may be registered by payment of a registration fee of 10 cents.

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2. Printed circulars may bear the address, signature and date in writing.

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Articles of merchandise may be registered by the payment of a registration fee of 10 cents, subject to proper examination. The name and address of sender must be written or printed on each package offered for registration.

All packages sent as mail matter not charged with letter postage must be unsealed and subject to examination by postmaster. If not so arranged, letter postage will be charged. Packages may bear the name and address of sender, also the list of articles contained therein.

POSTAL NOTES are payable to bearer at any money order office designated by purchaser of the note.

The amount may not exceed five dollars and will cost 3 cents.

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